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Abundance and Run Timing of Adult Pacific Salmon in Big Creek, Becharof National Wildlife Refuge, Alaska, 2000-2002

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Key words: chum salmon, chinook salmon, coho salmon, Big Creek, Becharof National Wildlife Refuge, resistence-board weir, weir

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Table of Contents

List of Figures

List of Tables

Table Page

List of Tables (continued)

Table Page

List of Tables (continued)

List of Appendices

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Abstract.-Beginning in 2000, the King Salmon Fish and Wildlife Office installed a weir on Big Creek, Becharof National Wildlife Refuge to estimate salmon escapement. Salmon are an important Refuge resource and accurate escapement estimates are needed to conserve these resources. Prior to the weir, only aerial survey data, focused on chinook salmon, were available. From 2000 to 2002, five species of Pacific salmon and six resident fish species were passed through the weir. The annual salmon escapement was highly variable for the main spawning populations with an average escapement of 14,450 for Chum salmon *Oncorhynchus keta,* the most abundant species, followed by chinook *O. tshawytscha* (2,246) and coho salmon *O. kisutch* (2,099). Less than 100 sockeye *O. nerka* and pink salmon *O. gorbuscha* migrated through the weir each year. In 2000 and 2001, the seasonal female chum salmon sex ratios were less than 33%, and increased to 43% in 2002. Chum salmon age composition varied between years, with age-classes 0.3 and 0.4 being the most abundant. The seasonal female chinook salmon sex ratios varied from 61% in 2000 to 34% in 2002. Age-class 1.3 and 1.4 chinook salmon were more abundant in 2000 and 2001, while in 2002, age-class 1.2 chinook were more abundant. Female coho salmon sex composition varied from 30% in 2000 to 50% in 2001. Age 2.1 was the most abundant coho salmon age-class (70%) sampled during all three years.

Introduction

The Alaska National Interest Lands Conservation Act (ANILCA) specifically mandates that fish populations and their habitats be conserved in their natural diversity within the Becharof National Wildlife Refuge (Refuge; USFWS 1994). The conservation of adult chum *Oncorhynchus keta*, chinook *O. tshawytscha*, coho *O. kisutch*, sockeye *O. nerka*, and pink salmon *O. gorbuscha* stocks that are exploited in commercial, sport, and subsistence fisheries require accurate monitoring of escapements to ensure these salmon stocks are being maintained for future use. Big Creek, the largest tributary to the Naknek River, provides important spawning habitat for chinook, chum, and coho salmon. The majority of adult salmon spawning in Big Creek likely occurs within the Refuge; therefore, it is necessary to determine current escapement levels to ensure the conservation of refuge originating salmon stocks. In addition, the need for information on human use and dependence upon Refuge resources is becoming more important as competition and conflict develop between user groups for finite resources (USFWS 1994). Collecting salmon escapement data from Big Creek will provide managers with stock status data that can be used to manage this fishery.

Management decisions based on this information will benefit commercial, subsistence, and sport users.

Conflicts between commercial, subsistence, and sport fishermen have increased in recent years because of increasing competition for a limited resource. Chinook salmon harvest in the commercial fishery has declined in recent years despite increased effort (ADF&G 1998, 2001, and 2002). From 1977 to 1997, there was a 500% increase in commercial fishing effort during the pre-emergency order of the Naknek/Kvichak district fishery, but despite the increase in effort, chinook salmon harvest decreased (ADF&G 1998). The average commercial chinook salmon harvest during 1977-1986 was 7,954, but from 1987 to 1996 this average harvest decreased to 5,547. In 1997, only 2,839 chinook salmon were harvested in the commercial fishery (Naknek/Kvichak District), a 50% decline from the previous 10-year average (1987-1996). However in 1988, declines in chinook salmon indices prompted the Alaska Department of Fish and Game (ADF&G) to eliminate the month of May from the commercial salmon fishing season (ADF&G 1989). Therefore, removing a month from the fishing season may account for the decline observed in the average catch rate between 1987-1996.

Harvest of chinook salmon by the subsistence fishery was about 9% of the average total harvest between 1970 and 1997 (Dunaway and Jaenicke 2000). However, during 1993-1997, the subsistence harvest was higher (range = 1,199 to 1,680) than the average for all years combined (1970 to 1997: 924 fish), and accounted for a larger proportion of the average harvest (15%). Despite the increase in subsistence harvest, there has not been a similar increase in the total harvest (i.e., commercial, sport, and subsistence).

The Naknek River supports the second most popular sport fishery in the ADF&G Southwest Management Area (SWMA) (Minard et al. 1998). Sport fishing on the Naknek River increased from an average of 5,000 angler days in the late 1970's to a record 18,372 angler days in 1988. There was a decline from 1989 to 1994, but in 1997, effort was estimated at 16,645 angler days and is expected to increase in the future (Minard et al. 1998; Dunaway and Jaenicke 2000). Chinook and coho salmon are the primary targets of sport fishermen in the lower Naknek River.

The Naknek River chinook salmon sport fishery accounts for 25% of all chinook salmon harvested in the SWMA (Dunaway and Jaenicke 2000). Harvest peaked in 1987 when sport anglers harvested an estimated 11,419 chinook salmon (Coggins and Bingham 1993). From 1992 to 1997, 30% of the total chinook salmon harvest in the Naknek River was taken by sport fishermen (Minard et al. 1998). Annual sport fish harvests averaged 3,003 chinook salmon during that time. In an attempt to balance an increasing sport harvest with escapement, ADF&G has implemented seasonal commercial and sportfishing closures and harvest and gear restrictions to protect chinook salmon in the Naknek River drainage. The biological escapement goal for chinook salmon in the Naknek River drainage is 5,000 spawners. This goal is an index count, provided by aerial surveys and therefore, a minimum estimate of escapement.

Coho salmon account for 25% of all salmon harvested in the SWMA, with harvest and effort increasing (Dunaway and Jaenicke 2000). Prior to 1977, less than 1,000 coho salmon were harvested by sport fishermen in the SWMA, but harvest has increased to an average of 10,239 since 1992 (Minard et al. 1998). Similar trends have occurred in the Naknek River. In 1977, only 297 coho salmon were harvested from the Naknek River, but in 1996 the known sport harvest was 4,964 fish. The Naknek River coho salmon fishery provides recreational opportunity and economic benefit to the King Salmon and Naknek communities. The ADF&G has not established a biological escapement goal for coho salmon in the Naknek River drainage and escapement data is not available; therefore, it is not possible to assess fishery impacts on the entire run.

The ADF&G has conducted aerial surveys to index chinook salmon escapement within the primary spawning areas of the Naknek River drainage, including King Salmon, Big, and Paul's creeks and the mainstem, since 1967. Aerial survey counts are unexpanded index counts and are considered minimum estimates of escapement (Minard et al. 1998). Currently, these surveys do not indicate trends in chinook salmon escapement, and only represent an index of instantaneous escapement. In addition, the condition under which these surveys are conducted is dependent upon several factors including survey conditions (i.e., water clarity and weather). Therefore, aerial surveys may not be reliable indicators of population trends. Although possibly inaccurate, data from aerial surveys indicate that approximately 88% of the chinook salmon escapement in the Naknek River drainage is observed in Big Creek and the mainstream. From 1970 to 1999, the total chinook salmon unexpanded index estimates in the Naknek River drainage ranged between 2,536 and 11,730 fish. Chinook salmon index estimates in Big Creek during the same years varied between 490 and 4,220 while estimates in King Salmon and Paul's creeks were usually less than 1,000 fish in any year. Currently, no program exists to assess spawning escapement or overall exploitation of Naknek River coho salmon. Declines in some coho salmon populations in the SWMA may be due to excessive harvest, but the lack of escapement data prevents managers from verifying this conclusion (Minard et al. 1998). The lack of escapement data has become a major concern, and without this information it is difficult to determine the health of coho salmon stocks and determine appropriate harvest goals.

In 2000, the King Salmon Fish and Wildlife Field Office (KSFO) initiated a multi year study on Big Creek to: (1) enumerate escapement of chum, chinook, coho, sockeye, and pink salmon in Big Creek; (2) describe the run timing of chum, chinook, coho, sockeye, and pink salmon through the weir; (3) estimate the weekly age and sex composition of spawning chum, chinook, coho, sockeye and pink salmon in Big Creek, such that simultaneous 90% confidence intervals have a maximum width of 0.20; (4) estimate the mean length of chum, chinook, coho, and sockeye salmon by sex and age; and (5) characterize current public use on Big Creek and Becharof National Wildlife Refuge lands by conducting a general survey of boaters passing the weir.

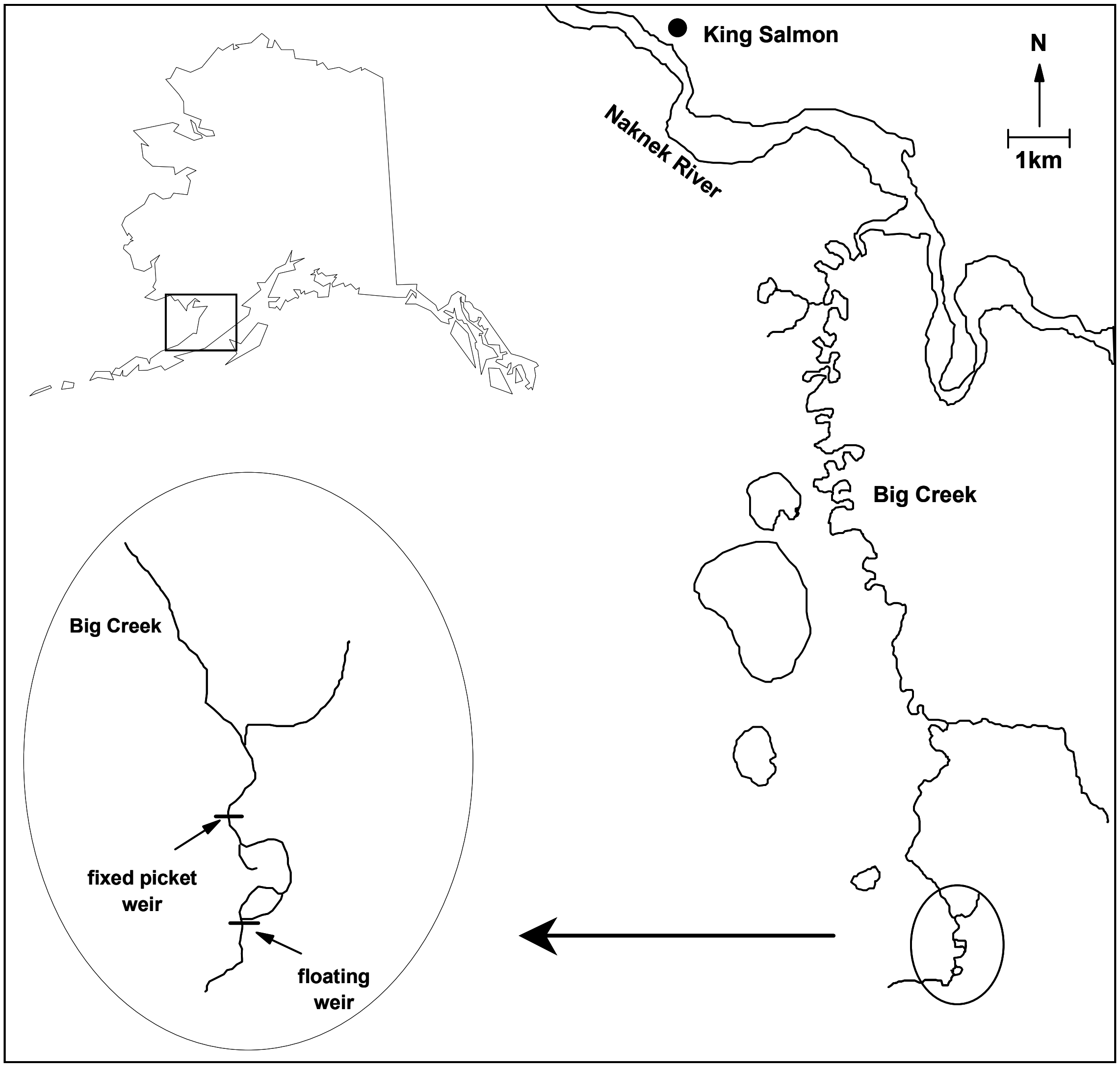

Figure 1. Map of Big Creek showing the fixed picket and floating weir sites, Becharof National Wildlife Refuge, Alaska.

Study Area

Big Creek originates in the mountains south of Brooks Lake in Katmai National Park and flows northwest about 60 km before joining the Naknek River, 6 km east of King Salmon, Alaska (Figure 1). The drainage contains numerous tributaries, small lakes, and ponds and is almost entirely located within the Refuge boundaries. Big Creek is a clear water stream supporting five species of Pacific salmon and spawning populations of Dolly Varden *Salvelinus malma*, Arctic grayling *Thymallus arcticus,* northern pike *Esox lucius*, and rainbow trout *O. mykiss*.

The KSFO has installed and operated a weir on Big Creek from 2000 to 2002. In 2000 and 2001, a fixed-picket weir 35-m in length was installed on Big Creek approximately 34 river km upstream of the confluence with the Naknek River (58° 31.249'N, 156° 34.265'W; Figure 1). The fixed picket weir was operated 18 June to 7 September in 2000 and 24 June to 15 August in 2001. On 15 August 2001, the fixed-picket weir was replaced with an angled modified resistance-board weir located about 400 m upstream of the original weir site (58° 31.049'N, 156° 34.235'W; Figure 1). This section of the creek is characterized by glides and riffles flowing over sand, gravel, and small cobble substrate. Willow, birch, and grasses dominate the riparian zone. Maximum discharge often occurs during spring breakup, but periods of high discharge are often generated by heavy rains that occur between late July and early September.

Methods

Weir Operation

The KSFO installed and operated a weir on Big Creek from 2000 to 2002. In 2000 and 2001, the weir was constructed of 12 mm diameter electrical metal tubing (EMT) pickets separated by 38 mm lengths of polyvinyl chloride pipe (PVC). Three-mm diameter aircraft cable was used to string the pickets and PVC spacers together, and clamps were attached to the ends of the cables to create 3 m long weir panels. The weir panels were supported by fence posts and an 8-mm diameter galvanized aircraft cable stretched across the stream. The supporting cable was attached to the stream banks using deadmen anchors buried vertically at a depth that allowed the cable to be suspended just above the water surface. Weir panels were hooked together and placed across the channel at an angle which helped direct upstream migrating fish into the trap box. The continuous weir panel was tilted downstream, in relation to the stream bed, to shunt debris to the water surface, and thereby maintaining free-flow of water through the pickets. A boat gate constructed of aluminum channel and steel black pipe was installed in the weir to allow passage of boats through the weir. The fixed picket weir was operated 18 June to 7 September in 2000 and 24 June to 15 August in 2001.

On 15 August 2001, the fixed-picket weir was replaced with an angled modified resistance-board weir located about 400 meters upstream of the original weir site. The weir was constructed from 4.6-m lengths of polyvinyl chloride electrical conduit pickets separated by 38-mm lengths of PVC. Three-mm diameter aircraft cable was used to string the pickets and PVC spacers together, and clamps were attached to the ends of the cables to create weir panels 1.2 m in width. The panels were attached to an 8-mm diameter cable anchored to the stream bottom with duck bill anchors. Adjustable resistence boards, constructed of plywood (6 mm thick) and waterproof Styrofoam, were attached to the downstream end of the weir panels to provide flotation. Four weir panels were modified from this design to allow boats upstream access. The modified resistence board weir was operated until 13 October.

In 2002, the resistance-board weir was further modified to form a V-shape which directed fish toward the trap box and a passage chute. To prevent fish from squeezing between pickets, picket spacing was reduced to 32 mm and additional stringers (3-mm diameter aircraft cable) were added to increase panel rigidity. The V-shaped resistance-board weir was operated from 29 June to 7 September when the trap box was damaged during high water. During the season, the entire weir was inspected, cleaned, and maintained daily to insure integrity.

To facilitate fish passage and reduce the number of fish handled at the weir, a passage chute was installed adjacent to a video box in 2002. The passage chute was artificially lit from the top and side to provide the illumination necessary to record images with the digital video equipment. A single camera was mounted in a sealed wooden video box filled with clean water. A clear Plexiglas window was fixed to the front of the box. The distance between the lens of the camera and the window provided separation between upstream migrant fish and the lens, as needed to obtain full-frame images of large fish like chinook salmon. Video images from the underwater camera were recorded using a Digicorder 2000 Deluxe made by Alpha System Laboratory.

A trap box installed in the weir was used to capture salmon for weekly biological sampling. When fish were not being collected for sampling, the trap box was closed and fished were passed through an opening in the weir or through a passage chute. During sampling, a dip-net was used to remove fish from the trap box at least once a day or more often as the number moving through the weir increased. Weekly samples of each salmon species were examined for gill-net marks, measured, sexed, and scales were extracted for age analysis. Scales were not collected from pink salmon. In cooperation with an egg-retention study on Big Creek, additional information was collected from weekly samples in 2001 and 2002. This information included classification of chum and chinook salmon into one of three categories: net-marked (i.e., they have a distinct net mark, but may also have fungus), fungus (i.e., have fungus but no distinct net-mark), or clean (i.e., have no fungus or net marks). Partial data from the egg-retention study are included in this report, (i.e., gill-net marks and fungus), but all other data are reported in the egg-retention report (Whitton, in progress). Fish in excess of the target sample size were counted and identified as they migrated through the weir. Fish were not allowed to hold downstream of the weir. If this occurred, the trap box was closed and the counting panel or passage chute was opened to facilitate upstream passage.

To monitor stream discharge on Big Creek, water velocity was measured periodically over a range of stage heights. Stage heights were measured twice daily from a staff gauge and averaged (McMahon et al.1996). To estimate discharge, water velocity was measured with a Marsh-McBirney model 201 flow meter. The relationship between discharge and stage height was determined using linear regression. The relationship between the two variables was used to convert average stage height readings to discharge for days when discharge was not measured. In 2000 and 2001, discharge and stage height measurements were taken near the fixed-picket weir site, but in 2002, measurements were taken near the floating weir site.

In 2000, a Ryan Instruments thermograph (model RTM 2002-2) was installed at the weir to monitor water temperatures. It was replaced in 2001 and 2002 with a Hobo® thermograph (model number H08-001-02). Water temperature was recorded every 2 h and summarized as daily maximum, minimum, and mean.

Biological Data

Data on Pacific salmon age, sex, and length (ASL) were collected using a temporally stratified sampling design (Cochran 1977), with statistical weeks defining strata. All species were sampled weekly for ASL information, and the samples were collected uniformly throughout the week (Sunday through Saturday). To avoid potential bias caused by the selection or capture of individual fish, all target species within the trap were included in the sample even if the target number for a species was exceeded. Non-target species were netted out of the trap box, tallied, and released upstream. Resident species captured at the weir during sampling were counted and released. In 2002, data collection was expanded to assist the ADF&G with a chinook salmon population estimate on the Naknek River. All chinook salmon passing the weir were sampled and examined for marks every other day.

During each week, a sample of each salmon species was trapped, examined for gill-net marks, length measured from mid-eye-to-fork of the tail (MEF; measured to the nearest mm), sex determined, and scales collected for aging. Scale samples were removed from the preferred area on the left side of adult salmon (Jearld 1983). Scales samples were cleaned and mounted on gummed scale cards. In 2000 and 2001, impressions of scales were made on cellulose acetate cards and examined with a microfiche reader. In 2002, the ADF&G office in Anchorage pressed and aged the scales. Salmon ages are reported according to the European method (Koo 1962), where the number on the right side of the decimal indicates the number of winters in freshwater and the number on the left side indicates the winters spent in salt water.

Maximum weekly sample size goals were established so that simultaneous 90% interval estimates of age composition for each week have maximum widths of 0.20 (Bromaghin 1993; Table 1). Sample sizes obtained using these methods were increased to account for the expected number of unreadable scales. However, the derivation of maximum sample size goals was based on a multinomial sampling model (sampling with replacement or small samples relative to a large population). For some salmon species, the sample size goal was expected to be a substantial fraction of the passage in some weeks; therefore, during weeks of low passage when the maximum sample size goal could not be practically obtained, about 20% of the weekly escapement was sampled. This was sufficient to describe the age composition and reduce the number of fish handled at the weir. For sample size determination, age categories were defined as the total age (fresh water and ocean age combined) for all species (Table 1).

Table 1. Maximum weekly sample size goals based on a sampling model (Bromaghin 1993).

Species	Number of Age Categories	Sample Size	Percent Unreadable	Adjusted Sample Size
Chum	4	121	10	135
Chinook	7	145	10	162
Coho	3	109	10	122
Sockeye	4	121	10	135

Public Use Survey

During 2000-2002, boats heading downstream were interviewed opportunistically to determine the following information, (1) primary purpose for visit (hunting, fishing, other); (2) secondary purpose (hunting, fishing, other); (3) reason (subsistence, sport, or other); (4) residence (city, state, or country of residency); (5) guiding status (guided or unguided); (6) target species and the number kept; (7) group size; and (8) time spent on the Refuge (hours or days). In 2000 additional data was collected from boaters that had been fishing including numbers kept and released, species, and hours fished to estimate harvest and catch rates. After the fixed picket weir was replaced with a resistance board weir, boaters were less likely to be interviewed because the new weir design allowed boaters to motor over the weir without stopping.

Data Analysis

Characteristics of fish passing through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum m, the proportion of species *i* passing the weir that were of sex *j* and age *k* (p_{ijkm}) was estimated as

$$\hat{p}_{ijkm} = \frac{n_{ijkm}}{n_{i++m}}, \tag{1.1}$$

where n_{ijkm} denotes the number of fish of species i, sex j, and age k sampled during stratum m and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{i++m} denotes the total number of fish of species i sampled in stratum m. The variance of $\hat{p}_{ijkm}$ was estimated as

$$\hat{v}\left(\hat{p}_{ijkm}\right) = \left(1 - \frac{n_{i++m}}{N_{i++m}}\right)\frac{\hat{p}_{ijkm}\left(1 - \hat{p}_{ijkm}\right)}{n_{i++m} - 1} \tag{1.2}$$

where N_{i++m} denotes the total number of fish of species i passing the weir in stratum m. The estimated number of fish of species i, sex j, and age k passing the weir in stratum m (N_{ijkm}) was

$$\hat{N}_{ijkm} = N_{i+m}\hat{P}_{ijkm} \tag{2.1}$$

with estimated variance

$$\hat{v}(\hat{N}_{ijkm}) = N_{i++m}^2 \hat{v}(\hat{p}_{ijkm}) \tag{2.2}$$

Estimates of proportions for the entire period of weir operation were computed as weighted sums of the stratum estimates, i.e.,

$$\hat{p}_{ijk} = \sum_m \left\{ \frac{N_{i++m}}{N_{i+++}} \right\} \hat{p}_{ijkm} \tag{3.1}$$

and

$$\hat{v}\left(\hat{p}_{ijk}\right) = \sum_m \left(\frac{N_{i++m}}{N_{i+++}} \right)^2 \hat{v}\left(\hat{p}_{ijkm}\right) \tag{3.2}$$

The total number of fish in a species and age category passing the weir during the entire period of operation was estimated as

$$\hat{N}_{ik} = \sum_m \hat{N}_{ikm} \tag{4.1}$$

with an estimated variance

$$\hat{v}\left(\hat{N}_{ik}\right) = \sum_m \hat{v}\left(\hat{N}_{ikm}\right). \tag{4.2}$$

If the length of fish of species i, sex j, and age k sampled in stratum m is denoted x_{ijkm}, the sample mean length of fish of species i, sex j, and age k within stratum m was computed as,

$$\bar{x}_{ijkm} = \frac{\sum x_{ijkm}}{n_{ijkm}}, \tag{5.1}$$

with corresponding sample variance s^2_{ijkm}

$$s^2_{ijkm} = \left(1 - \frac{n_{ijkm}}{\hat{N}_{ijkm}}\right) \frac{\sum \left(x_{ijkm} - \bar{x}_{ijkm}\right)^2}{n_{ijkm} - 1}. \tag{5.2}$$

The mean length of all fish of species i, sex j, and age k $\left(\hat{\bar{x}}_{ijk}\right)$ was estimated as a weighted sum of the stratum means, i.e.,

$$\hat{\bar{x}}_{ijk} = \sum_m \left(\frac{\hat{N}_{ijkm}}{\hat{N}_{ijk}}\right) \bar{x}_{ijkm}. \tag{6.1}$$

An approximate estimator of the variance of $\hat{\bar{x}}_{ijk}$ was obtained using the delta method (Seber 1982),

$$\hat{v}\left(\hat{\bar{x}}_{ijk}\right) = \sum_m \left\{ \hat{v}\left(\hat{N}_{ijkm}\right) \left[\frac{\bar{x}_{ijkm}}{\sum_x \hat{N}_{ijkx}} - \sum_y \frac{\hat{N}_{ijky}}{\left(\sum_x \hat{N}_{ijkx}\right)^2} \bar{x}_{ijky} \right]^2 + \left(\frac{\hat{N}_{ijkm}}{\sum_x \hat{N}_{ijkx}}\right)^2 s^2_{ijkm} \right\}. \tag{6.2}$$

During sampling, biological data were collected on a weekly basis. However, for the purposes of data analysis, strata were redefined to account for escapement during weeks when few or no fish were sampled (Appendix 1).

Results

Weir Operation

In 2000, operation of the weir began 19 June and continued through 7 September when it became inoperable due to high water. Portions of the weir were open for 8 to 11 h during two high water events on19 July and 20 August. During those days when high water occurred, it is possible some fish passed the weir undetected. Daily stream discharge during weir operation in 2000 varied between 7.5 and 18.7 m^3/s, but stream discharge was never measured when stage heights were above 0.5 m (discharge = 14.3 m^3/s) (Figure 2). Stage heights during weir operation varied from 0.3 to 0.7 m. Water temperatures at the weir varied from 8.4° C to 18.3° C (Figure 3).

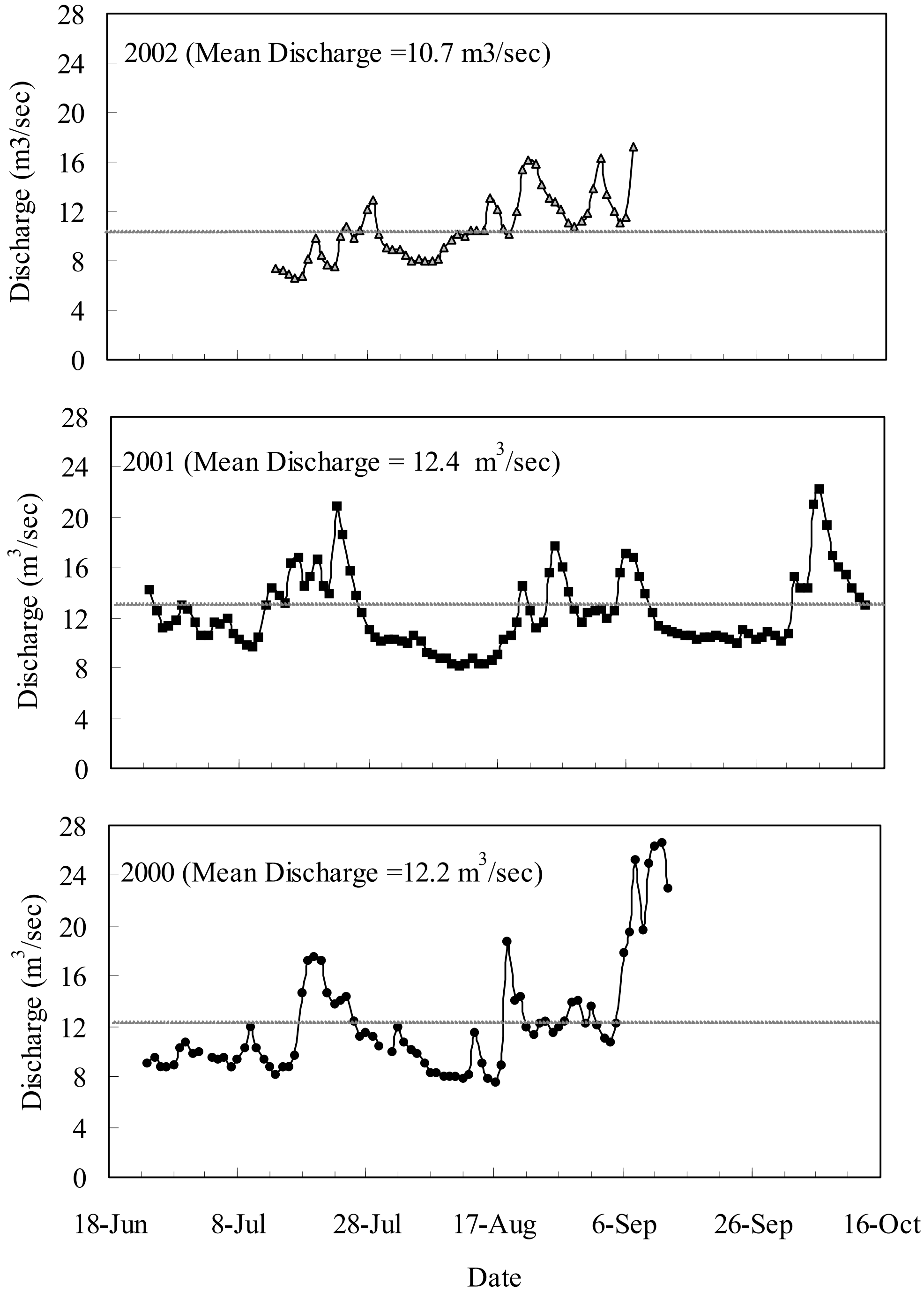

Figure 2. Stream discharge near the Big Creek weir, 2000-2002.

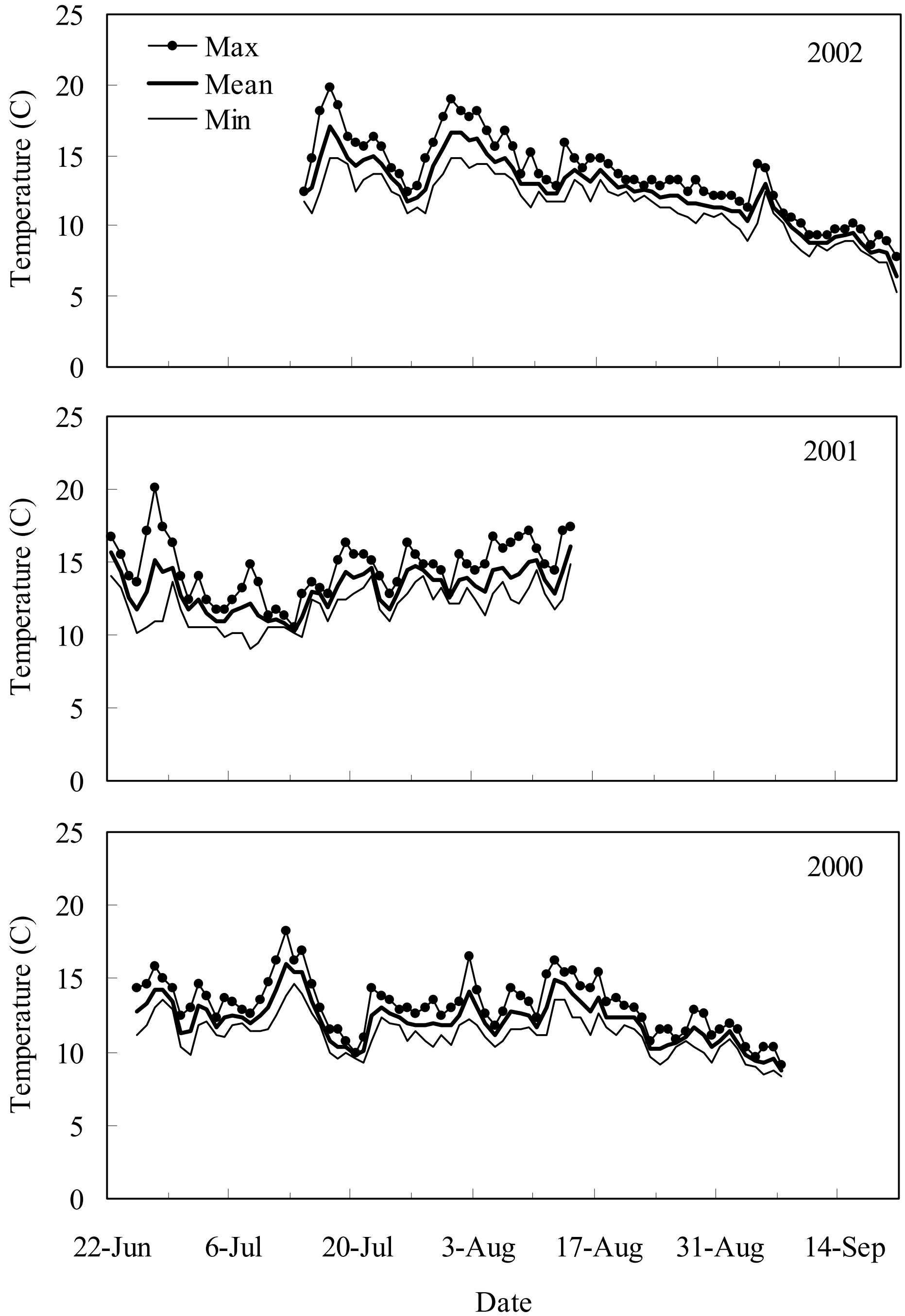

Figure 3. Maximum, mean, and minimum water temperatures (°C) at the Big Creek weir, 2000-2002.

In 2001, operation of the weir began 24 June and continued through 12 October when it was removed prior to ice-up. The fixed picket weir was not operational during two high water events (13 and 23 to 24 July). Stage height at the weir on 23 July was 0.8 m and the estimated discharge was 20.9 m^3/sec. During this high water event, the weir was not operational for about 33 h. During additional high water events (5-9 September and 5-8 October), the newly installed floating weir was often submerged and fish was observed swimming over the top. Daily stream discharge during weir operation in 2001 varied between 8.1 and 22.2 m^3/s, but stream discharge was never measured when stage heights were above 0.7 m (discharge = 18.1 m^3/s) (Figure 2). Stage heights during weir operation varied from 0.3 to 0.9 m. Water temperatures at the weir varied from 9.0° C to 18.3° C (Figure 3).

In 2002, operation of the weir began on 29 June and continued through 7 September when it became inoperable due to high water. During the first two weeks of weir operation, damage to the trap box may be attributed to some fish escaping upstream without being counted. High water during 21-23 August submerged four boat gate panels and two regular panels, but no fish were observed swimming over the panels during 2 h of observation. Weir panels were modified by 1230 hours on 23 August. Daily stream discharge during weir operation in 2002 varied between 6.5 and 16.3 m^3/s, but stream discharge was never measured at stage heights above 0.5 m (discharge = 12.3 m^3/s) (Figure 2). Stage heights during weir operation varied between 0.4 and 0.8 m. Stage height and discharge measurements taken in 2002 are not directly comparable to those taken in 2000 and 2001 because they were taken in different locations. Water temperatures at the weir in 2002 varied from 9.0° C to 19.8° C (Figure 3).

Biological Data

In 2000, seasonal escapement of Pacific salmon above the Big Creek weir was 3,241 chum, 1,298 chinook, 969 coho, 80 pink, and 57 sockeye salmon. In 2001, seasonal escapement was 11,981 chum, 4,523 coho, 649 chinook, 38 sockeye, and 15 pink salmon. In 2002, seasonal escapement was 28,812 chum, 4,791 chinook, 806 coho, 45 sockeye, and 31 pink salmon. Incidental catches of rainbow trout, Dolly Varden, Arctic grayling, northern pike, round whitefish *Prosopium cylindraceum*, and longnose sucker *Catostomus catostomus* were also documented at the weir.

Chum salmon 2000.-An estimated 3,241 chum salmon migrated through the Big Creek weir in 2000 (Figure 4 and Appendix 2). Chum salmon were first recorded at the weir on 26 June, and the peak daily escapement occurred on 3 August (N=255). Chum salmon were observed at the weir until it was removed on 7 September. The sex composition for the entire season averaged 32% female, varying from 43% in late July to 10% in mid-August (Table 2). Chum salmon that could not be identified as male or female were not included in the analysis of sex composition (N=15). Four age-classes, 0.2, 0.3, 0.4, and 0.5, were identified from 641 of the 750 chum salmon sampled at the weir. Scale samples were not

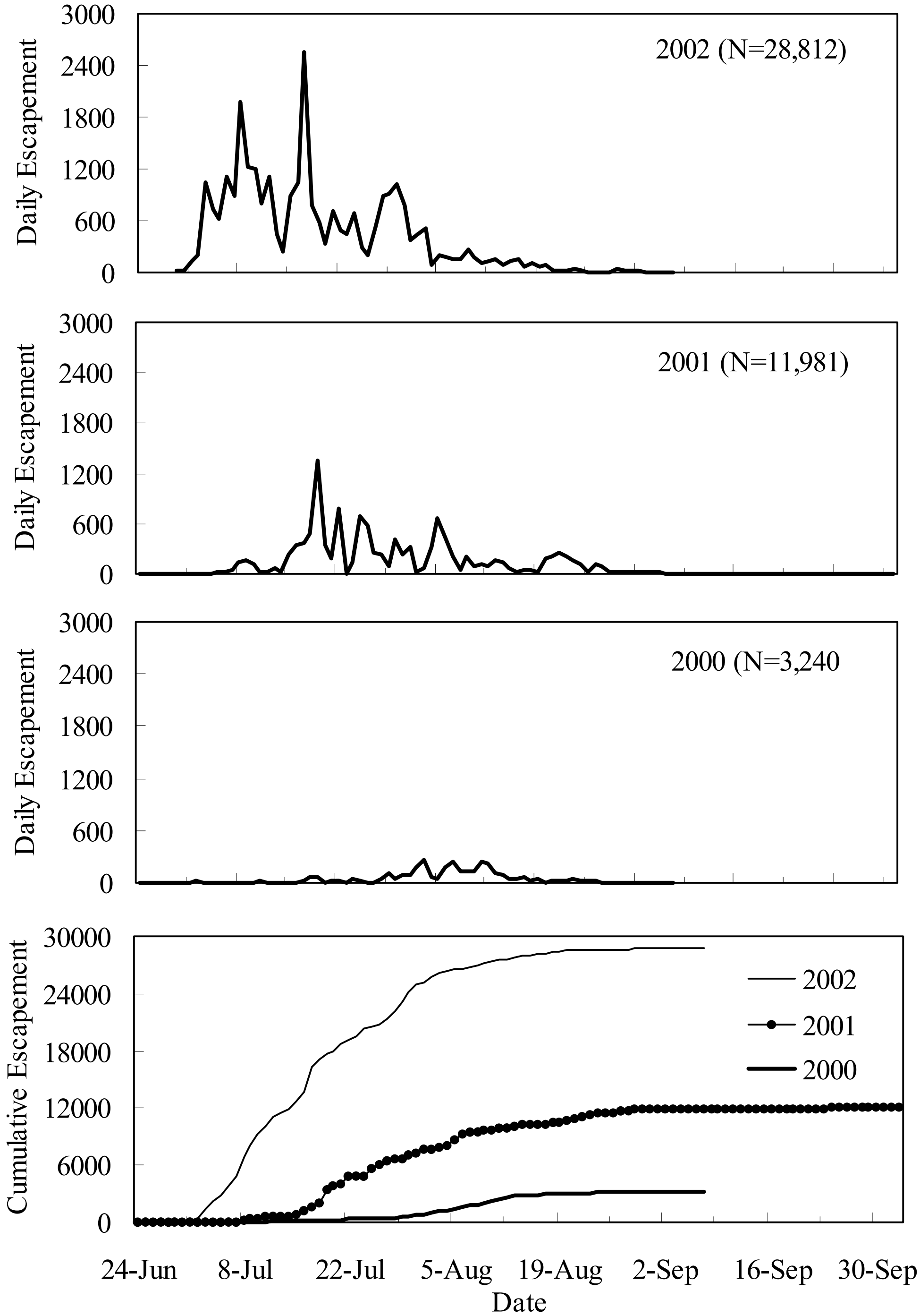

Figure 4. Daily and cumulative escapement of chum salmon through the Big Creek weir, 2000-2002.

Table 2. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek chum salmon by stratum, 2000.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jun 24 - Jul 1	34	22	12	65	35	3.6	27	15	1.5	42
Jul 2 - Jul 15	48	32	16	67	33	4.0	48	24	2.9	72
Jul 16 - Jul 22	90	65	25	72	28	3.6	155	59	7.7	214
Jul 23 - Jul 29	96	55	41	57	43	4.1	152	114	10.8	266
Jul 30 - Aug 5	170	105	65	62	38	3.3	463	287	24.7	750
Aug 6 - Aug 12	160	107	53	67	33	3.5	850	421	44.4	1,271
Aug 13 - Aug 19	92	83	9	90	10	2.8	392	42	12.0	434
Aug 20 - Sep 7	45	29	16	64	36	6.3	124	68	12.1	192
Total	735	498	237	68	32	1.7	2,211	1,030	55.3	3,241

collected from 70 chum salmon sampled at the weir (pathology fish: *N*=61, scales reabsorbed: *N*=9). Age 0.3 and 0.4 each accounted for 38% of the sample (Table 3). Fish that could not be aged were not included in the analysis of age composition (*N*=40). In 2000, the MEF of chum salmon ranged between 474 and 716 mm and about 80% of those sampled had MEF's between 541 and 650 mm (Figure 5). The MEF for male chum salmon ranged from 474 to 716 mm and from 495 to 700 mm for females (Table 4). The percent of net-marked chum salmon sampled at the weir peaked at 68% in mid-July (SE=6.7%) and declined to 0% after 19 August (Figure 6). The estimated percent of net-marked chum for the entire season averaged 34% (SE=1.1%).

Chum Salmon 2001.-An estimated 11,981 chum salmon migrated through the weir on Big Creek in 2001 (Figure 4 and Appendix 3). However, only partial counts were available during the days the weir was down (13 and 23 to 24 July). Chum salmon were first recorded at the weir on 28 June, and the peak daily escapement occurred on 19 July (*N*=1,358). Chum salmon were observed at the weir until it was removed on 12 October. The sex composition for the entire season averaged 27% female, varying from 12% early in the run (24 June-7 July) to 51% in mid-August (Table 5). Four age-classes, 0.2, 0.3, 0.4, and 0.5, were identified from 1,048 of the 1,170 chum salmon sampled at the weir. Age 0.3 accounted for 93% of the sample (Table 6). Fish that could not be aged or did not have scale samples taken, were not included in the analysis of age composition (not aged: *N*=78, no scales: *N*=44). In 2001, the MEF of chum salmon ranged between 475 and 720 mm and about 85% of those sampled had MEF's between 541 and 650 mm (Figure 5). The MEF for male chum salmon ranged from 501 to 720 mm and from 475 to 672 mm for females (Table 4). The

Table 3. Estimated age composition (percent and number) and standard errors (SE) of Big Creek chum salmon by stratum, 2000.

					Escapement											
	Sample				0.2				0.3				0.4			
Stratum	*N*	0.2	0.3	0.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	41	0	15	24	0	0.0	0	0.0	37	1.2	15	0.5	58	1.2	25	0.5
2	54	0	9	43	0	0.0	0	0.0	17	2.6	12	1.8	80	2.8	57	2.0
3	80	1	32	47	1	1.0	3	2.1	40	4.4	86	9.3	59	4.4	126	9.4
4	46	3	17	25	7	3.3	17	8.9	37	6.5	98	17.4	54	6.8	144	18.0
5	140	3	59	71	2	1.1	16	8.3	42	3.8	316	28.3	51	3.8	380	28.7
6	149	36	63	49	24	3.3	307	42.0	42	3.8	537	48.5	33	3.6	418	46.1
7	87	46	25	16	53	4.8	229	20.9	29	4.4	125	18.9	18	3.7	80	16.2
8	44	32	10	2	73	6.0	140	11.4	23	5.6	44	10.8	4	2.8	9	5.4
Total[a]	641	121	230	277	22	1.5	712	49.9	38	2.0	1,233	63.4	38	1.9	1,239	60.5

[a] Sample sizes for the listed age classes do not equal the total sample size because age 0.5 (N=13) were not included as they were <2% of the total sample.

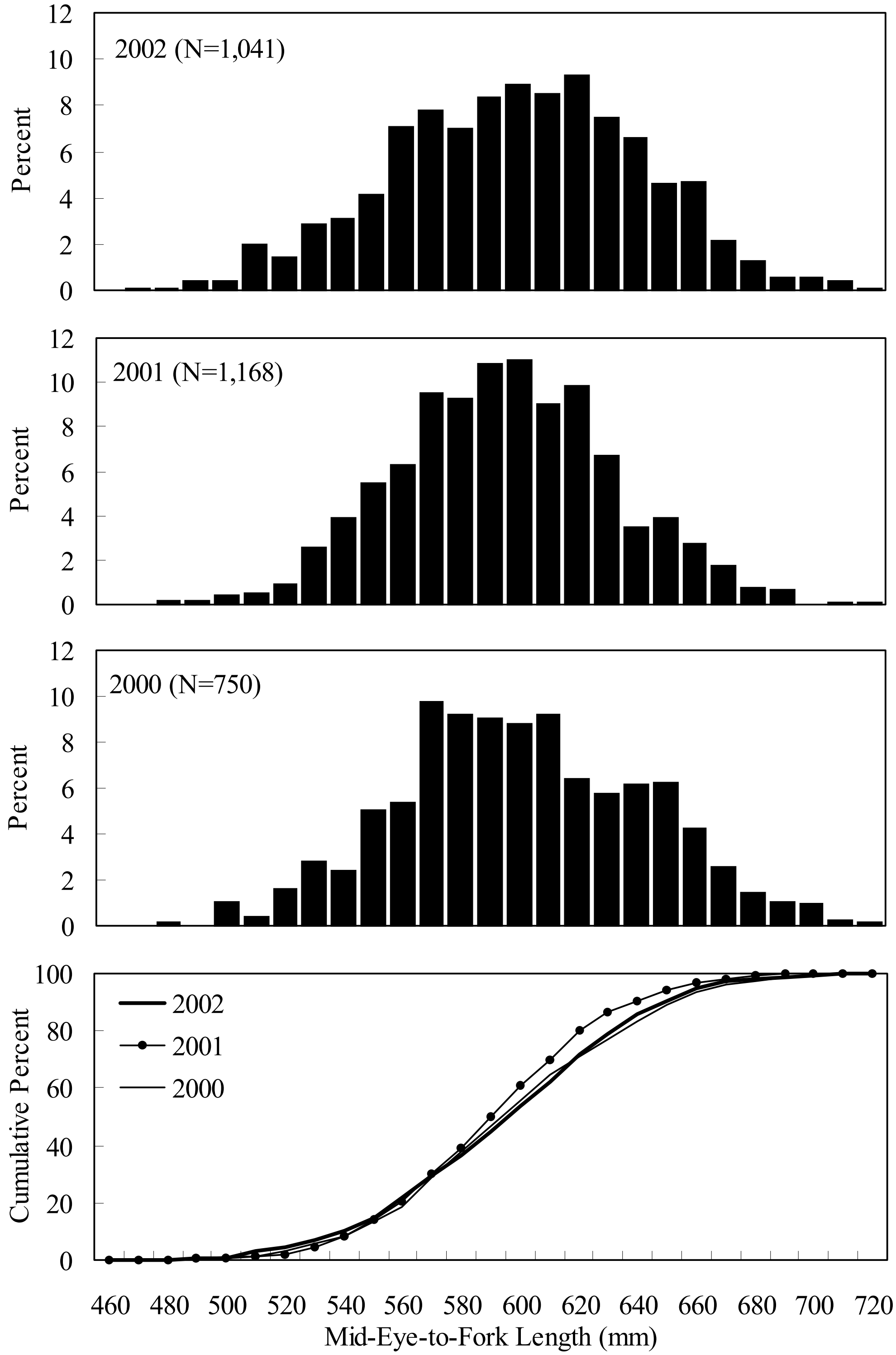

Figure 5. Length frequency and cumulative length frequency for chum salmon sampled at the Big Creek weir, 2000-2002.

Table 4. Estimated length composition (sample size, mean, standard error, and range) of Big Creek chum salmon by age and sex, 2000-2002. All lengths are mid-eye-to-fork of tail (mm).

	Males				Females				All Fish			
Age	*N*	Mean	SE	Range	*N*	Mean	SE	Range	*N*	Mean	SE	Range
						2000						
0.2	100	562	3.0	474-628	21	534	2.4	495-590	121	557	3.0	474-628
0.3	139	585	3.0	512-677	84	575	2.7	514-672	223	582	2.8	512-677
0.4	179	623	2.7	527-716	91	539	2.8	507-700	270	612	2.8	507-716
0.5	9	613	6.9	571-665	4	593	5.7	551-684	13	607	6.3	551-684
						2001						
0.2	13	596	4.4	542-649	7	581	12.2	526-621	20	591	4.6	526-649
0.3	677	603	2.4	501-720	288	566	2.2	475-672	965	593	2.4	475-720
0.4	41	612	4.3	517-701	15	579	3.8	543-616	56	602	3.8	517-701
0.5	3	675	3.2	647-688	1	580	---	---	4	652	3.1	580-688
						2002						
0.2	101	551	3.1	479-613	66	495	1.9	470-587	167	544	2.5	470-613
0.3	94	601	2.3	526-655	119	587	2.4	501-664	213	589	2.4	501-664
0.4	245	630	2.5	545-710	165	598	2.6	533-668	410	616	2.6	533-710
0.5	3	655	4.0	638-670	1	660	---	---	4	658	3.7	638-670

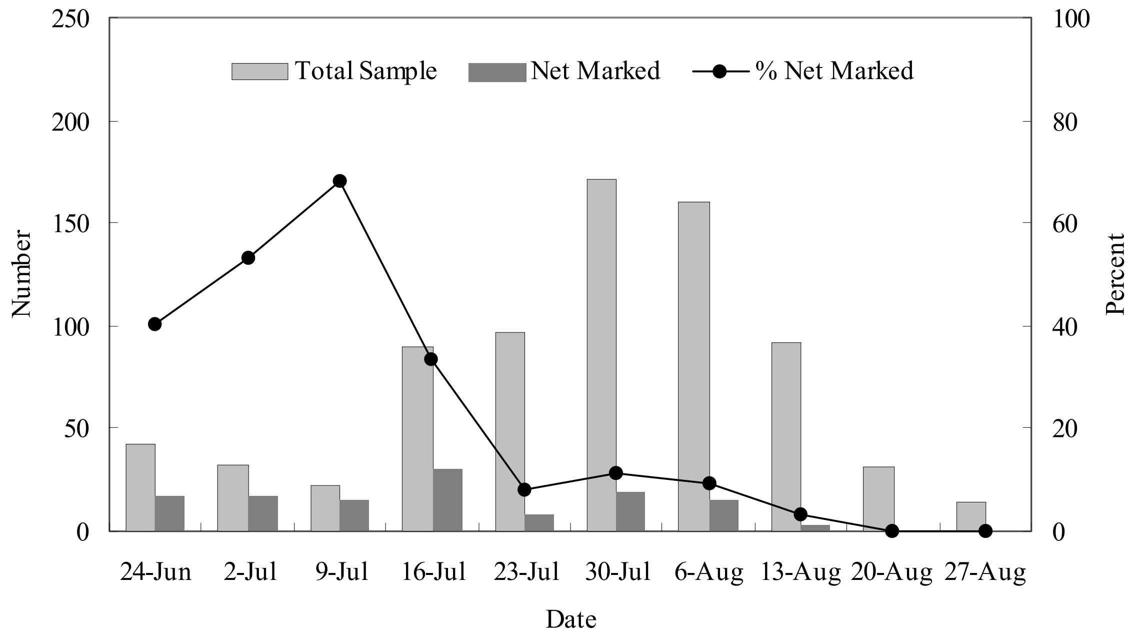

Figure 6. Number and percent of chum salmon with gill-net marks sampled each week at the Big Creek weir, 2000.

Table 5. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek chum salmon by stratum, 2001.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jun 24 - Jul 7	32	28	4	88	12	4.9	84	12	4.7	96
Jul 8 - Jul 14	111	88	23	79	21	3.5	448	117	19.6	565
Jul 15 - Jul 21	179	142	37	79	21	3.0	2,604	678	96.9	3,282
Jul 22 - Jul 28	172	124	48	72	28	3.3	1,911	740	87.9	2,651
Jul 29 - Aug 4	169	128	41	76	24	3.1	1,127	361	46.3	1,488
Aug 5 - Aug 11	170	128	42	76	24	3.2	1,326	435	55.5	1,761
Aug 12 - Aug 18	102	50	52	49	51	4.5	279	291	25.7	570
Aug 19 - Aug 25	162	84	78	52	48	3.6	587	545	41.3	1,132
Aug 26 - Oct 10	73	56	17	77	23	4.5	334	102	19.8	436
Total	1,170	828	342	73	27	1.3	8,700	3,281	159.7	11,981

Table 6. Estimated age composition (percent and number) and standard errors (SE) of Big Creek chum salmon by stratum, 2001.

					Escapement											
	Sample				0.2				0.3				0.4			
Stratum	*N*	0.2	0.3	0.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	27	0	13	12	0	0.0	0	0.0	48	8.3	46	8.0	45	8.3	43	7.9
2	95	0	88	6	0	0.0	0	0.0	93	2.5	523	13.9	6	2.3	36	12.9
3	168	3	155	10	2	1.0	59	32.8	92	2.0	3,028	66.1	6	1.8	195	58.5
4	160	3	153	4	2	1.0	50	27.6	96	1.6	2,535	41.7	2	1.2	66	31.8
5	158	2	153	3	1	0.8	19	12.6	97	1.3	1,441	19.7	2	1.0	28	15.3
6	153	6	141	5	4	1.5	69	26.5	92	2.1	1,623	36.7	3	1.4	58	24.3
7	93	1	86	6	1	1.0	6	5.6	93	2.5	527	14.3	6	2.3	37	13.4
8	138	3	128	7	2	1.2	25	13.2	93	2.1	1,050	23.5	5	1.8	57	19.9
9	56	2	51	3	4	2.3	15	10.2	91	3.6	397	15.7	5	2.8	23	12.4
Total[a]	1,048	20	968	56	2	0.5	243	54.8	93	0.8	11,170	95.4	5	3.1	543	78.9

[a] Sample sizes for the listed age classes do not equal the total sample size because age 0.5 (*N*=4) was not included as it was <1% of the total sample.

percent of net-marked chum sampled at the weir averaged 16% (SE=1.1%) for the season, varying from 47% in late June (SE=6.7%) to 0% after 12 August (Figure 7). The percent of chum salmon with just fungus averaged 8% (SE=0.8%) for the entire season, varying from 3% (SE=1.3%) in mid-July to 42% (SE=8.6%) in early September.

Chum Salmon 2002.-An estimated 28,812 chum salmon migrated through the Big Creek weir in 2002 (Figure 4 and Appendix 4). Chum salmon were first recorded at the weir on 29 June, and the peak daily escapement occurred on 17 July (*N*=2,552). Chum salmon were observed at the weir until it was removed on 7 September. The sex composition for the season averaged 43% female, varying from 48% in mid-July to 34% in early August (Table 7). Four age-classes, 0.2, 0.3, 0.4, and 0.5, were identified from 794 of the 1,041 chum salmon sampled at the weir. Scales samples collected from 83 chum salmon sampled at the weir were not aged or available for ageing (i.e., duplicate scale numbers or missing scales) and 164 scale samples were not readable (i.e., reabsorbed, dirty, missing, or regenerated). Age-class 0.4 accounted for 62% of the sample followed by 0.3 (28%; Table 8). In 2002, the MEF of chum salmon ranged between 470 and 710 mm and about 80% of those sampled had MEF's between 541 and 650 mm (Figure 5). The MEF for male chum salmon ranged from 479 to 710 mm and from 470 to 668 mm for females (Table 4). The percent of net-marked chum sampled at the weir averaged 10% (SE=1.2%) for the season, varying from 0% in late June and after early August to 26% (SE=3.6%) in mid-July (Figure 8). The percent of chum salmon with just fungus averaged 2% (SE=0.5%) for the entire season, varying from 0 to 3% (SE=1.5%) in early July.

Chinook Salmon 2000.-An estimated 1,298 chinook salmon migrated through the Big Creek weir in 2000 (Figure 9 and Appendix 2). Chinook salmon were first recorded at the weir on 24 June, and the peak daily escapement occurred on 3 August (*N*=435, 33.5% of the total escapement). Fifty percent of the escapement occurred during 1-3 August (*N*=649). Chinook salmon were not observed at the weir after 26 August. The sex composition for the entire season averaged 61% female, varying from 67% early in the run (24 June to 15 July) to 51% (16 to 29 July; Table 9). Five age-classes, 1.1, 1.2, 1.3, 1.4, and 1.5, were identified from 251 of the 318 chinook salmon sampled at the weir. Age-class 1.3 accounted for 50% of the sample followed by age-class 1.2 (34%) and age-class 1.4 (12%; Table 10). Fish that could not be aged were not included in the analysis of age composition (*N*=67). In 2000, the MEF of chinook salmon ranged between 419 and 1,010 mm and about 91% of those sampled had MEF's greater than 680 mm (Figure 10). The MEF for male chinook salmon ranged from 419 to 1,010 mm and from 611 to 980 mm for females (Table 11). The percent of net-marked chinook salmon sampled at the weir averaged 28% (SE=2.4%) for the season, varying from 7% (SE=1.3%) in late June to 30% in early July (SE=3.4%; Figure 11).

Chinook Salmon 2001.-Six hundred forty-nine chinook salmon were passed through the Big Creek weir in 2001 (Figure 9 and Appendix 3). However, on 13 and 23 to 24 July, the weir was not operational; therefore, partial estimates were recorded on these dates. Chinook salmon were first recorded at the weir on 24 June, and the peak daily escapement occurred on 6 August (*N*=69). A similar peak was observed on 22 July (*N*=64) the day before the weir

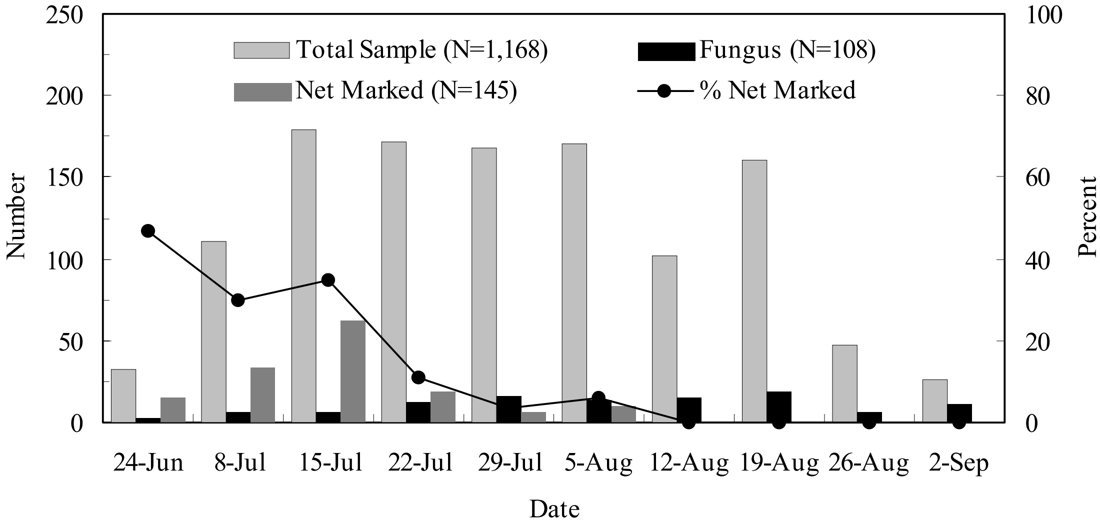

Figure 7. Number and percent of chum salmon with gill-net marks or fungus sampled at the Big Creek weir, 2001.

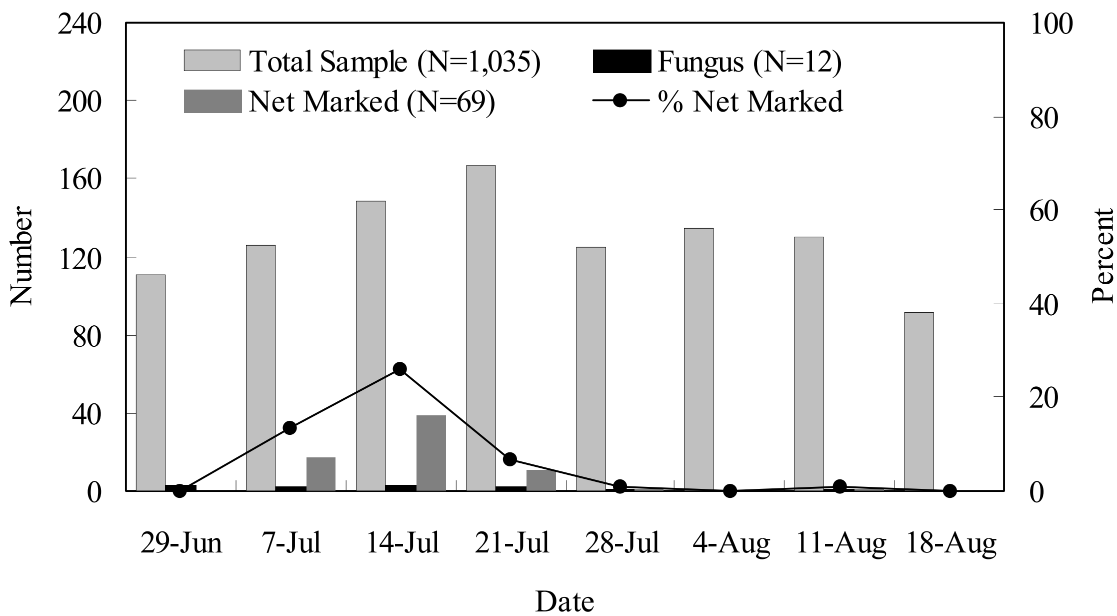

Figure 8. Number and percent of chum salmon with gill-net marks or fungus sampled at the Big Creek weir, 2002.

Table 7. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek chum salmon by stratum, 2002.

	Sample			Escapement						
				Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jun 29 - Jul 6	112	69	43	62	38	4.6	2,412	1,504	178.2	3,916
Jul 7 - Jul 13	128	71	57	55	45	1.4	4,240	3,403	334.2	7,643
Jul 14 - Jul 20	150	78	72	52	48	4.0	3,324	3,069	258.6	6,393
Jul 21 - Jul 27	168	99	69	59	41	3.7	1,968	1,371	123.9	3,339
Jul 28 - Aug 3	126	73	53	58	42	4.4	2,849	2,069	214.4	4,918
Aug 4 - Aug 10	135	89	46	66	34	3.9	796	411	46.6	1,207
Aug 11 - Aug 17	130	69	61	53	47	4.0	446	395	34.0	841
Aug 18 - Sep 7	92	60	32	65	35	4.6	362	193	25.3	555
Total	1,041	608	433	57	43	1.8	16,397	12,415	525.0	28,812

Table 8. Estimated age composition (percent and number) and standard errors (SE) of Big Creek chum salmon by stratum, 2002.

					Escapement											
	Sample				0.2				0.3				0.4			
Stratum	*N*	0.2	0.3	0.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	89	0	17	72	0	0.0	0	0.0	19	4.1	748	162.2	81	4.1	3,168	162.2
2	80	1	25	53	1	1.2	95	95.0	31	5.2	2,389	396.5	67	5.3	5,063	404.5
3	94	5	24	65	5	2.3	340	147.7	26	4.5	1,632	286.9	69	4.7	4,421	304.0
4	148	5	52	90	3	1.5	113	48.6	35	3.8	1,173	128.5	61	3.9	2,030	131.4
5	105	24	30	50	23	4.1	1,124	200.3	28	4.4	1,405	215.5	48	4.8	2,342	238.3
6	99	30	28	40	30	4.4	366	53.7	28	4.4	341	52.6	41	4.7	488	57.3
7	104	57	19	28	55	4.6	461	38.6	18	3.6	154	30.0	27	4.1	226	34.4
8	75	45	18	12	60	5.2	333	29.4	24	4.6	133	25.6	16	4.0	89	22.0
Total[a]	794	167	213	410	10	1.0	2,832	280.3	28	2.0	7,975	577.2	62	6.5	17,827	601.1

[a] Sample sizes for the listed age classes do not equal the total sample size because age 0.5 (*N*=4) were not included as they were <1% of the total sample.

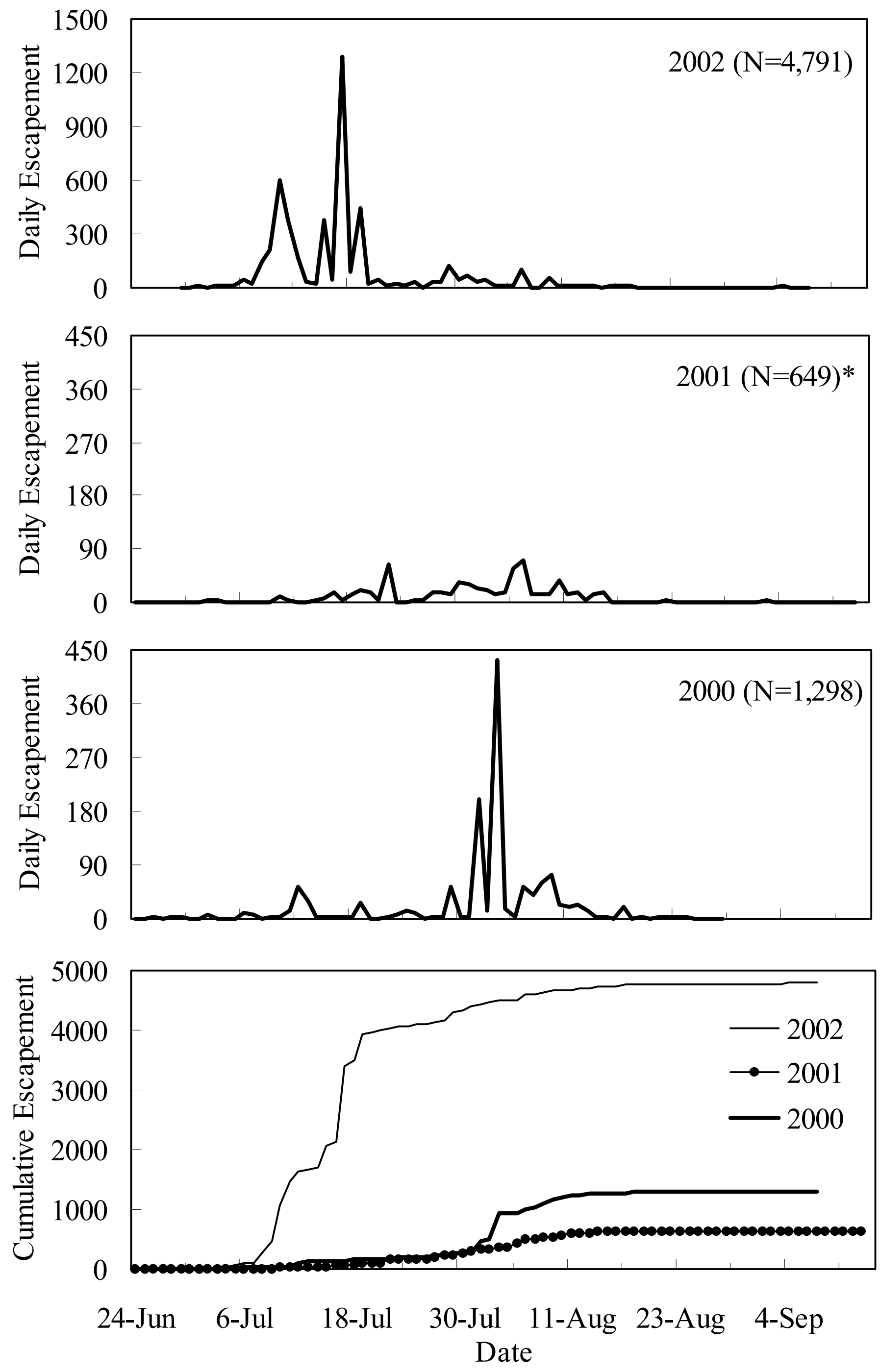

Figure 9. Daily and cumulative escapement of chinook salmon through the Big Creek weir, 2000-2002. The weir was not operational on 13 July and 23-24 July 2001.

Table 9. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek chinook salmon by stratum, 2000.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	% SE	Male	Female	SE	Total
Jun 24 - Jul 15	81	27	54	33	67	3.4	47	94	4.8	141
Jul 16 - Jul 29	41	20	21	49	51	6.6	64	68	8.7	132
Jul 30 - Aug 5	126	50	76	40	60	3.9	269	408	26.7	677
Aug 6 - Aug 12	59	21	38	36	64	5.6	104	188	16.4	292
Aug 13- Sep 7	11	5	6	45	55	14.1	25	31	7.9	56
Total	318	123	195	39	61	2.6	509	789	33.8	1,298

Table 10. Estimated age composition (percent and number) and standard errors (SE) of Big Creek chinook salmon by stratum, 2000.

						Escapement															
	Sample					1.1				1.2				1.3				1.4			
Stratum	N	1.1	1.2	1.3	1.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	55	3	6	32	13	5	2.4	8	3.4	11	3.3	15	4.7	58	5.2	82	7.4	24	4.5	33	6.4
2	32	1	6	17	8	3	2.7	4	3.6	19	6.1	25	8.1	53	7.8	70	10.3	25	6.8	33	8.9
3	111	5	38	56	12	5	1.8	30	12.2	34	4.1	232	28.0	50	4.4	342	29.5	11	2.7	73	18.3
4	43	1	19	21	2	2	2.1	7	6.3	44	7.1	129	20.7	49	7.1	143	20.8	5	3.0	14	8.8
5	10	0	8	2	0	0	0.0	0	0.0	80	12.1	45	6.8	20	12.1	11	6.8	0	0.0	0	0.0
Total[a]	251	10	77	128	35	4	1.1	49	14.6	34	2.8	446	36.7	50	3.0	648	38.9	12	1.8	153	23.1

[a] Sample sizes for the listed age classes do not equal the total sample size because age 1.5 (N=1) was not included as it was <1% of the total sample.

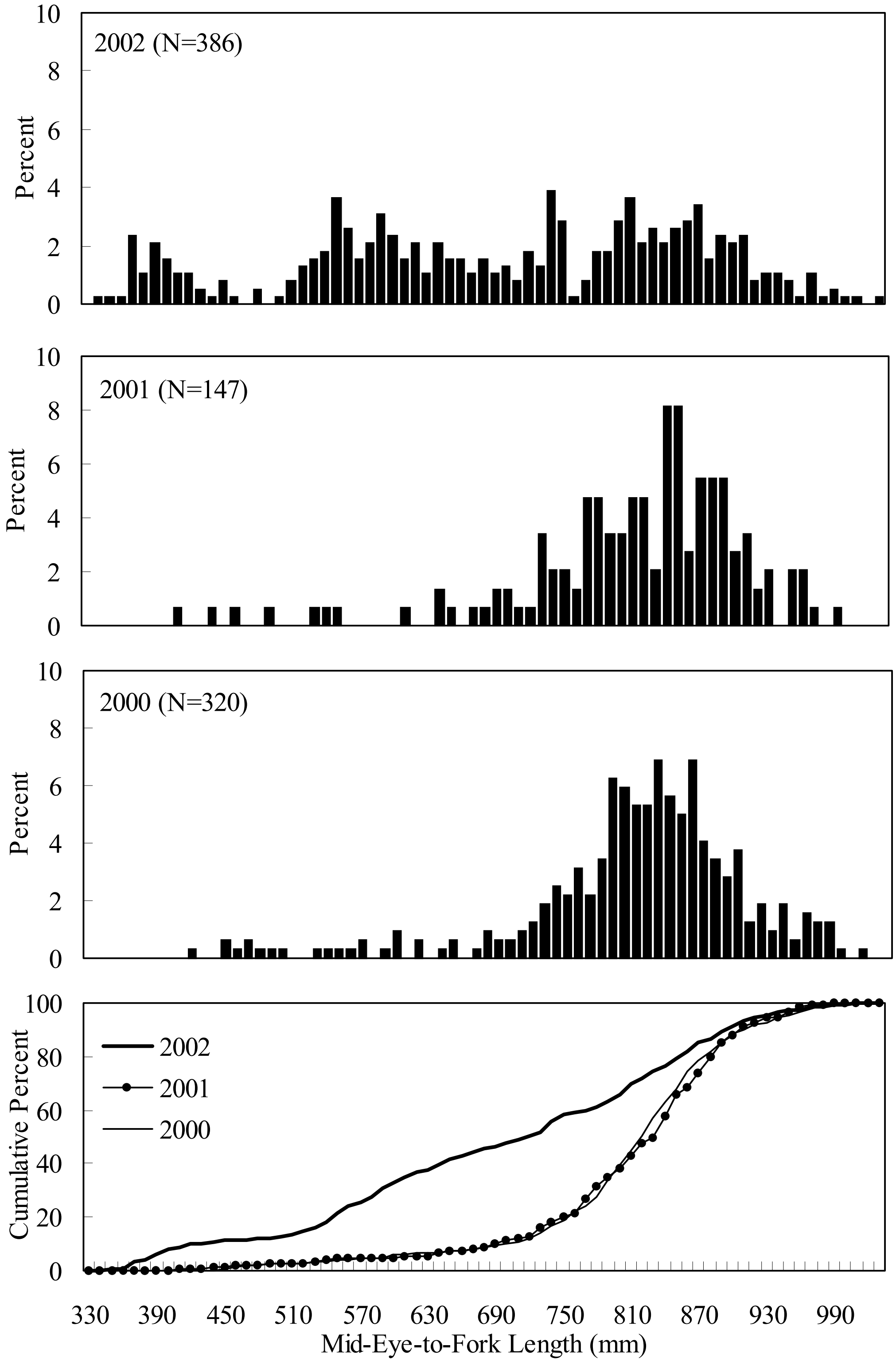

Figure 10. Length frequency and cumulative length frequency for chinook salmon sampled at the Big Creek weir, 2000-2002.

Table 11. Estimated length composition (sample size, mean, standard error, and range) of Big Creek chinook salmon escapement by age and sex, 2000-2002. All lengths are mid-eye to fork-of-tail (mm).

	Males				Females				All Fish			
Age	*N*	Mean	SE	Range	*N*	Mean	SE	Range	*N*	Mean	SE	Range
2000												
1.1	9	532	7.6	443-633	1	528	---	---	10	531	7.1	443-633
1.2	41	750	6.7	419-895	36	792	4.9	690-946	77	770	5.5	419-946
1.3	37	798	6.1	569-990	91	832	4.4	611-965	128	822	4.9	569-990
1.4	9	906	6.3	781-1,010	26	864	4.7	783-980	35	875	4.9	781-1,010
1.5	1	891	---	---	0	---	---	---	1	891	---	---
2001												
1.1	3	551	8.0	488-632	0	---	---	---	3	551	8.0	488-632
1.2	5	592	13.7	440-739	3	802	4.4	748-842	8	680	15.8	440-842
1.3	25	797	6.0	610-951	13	790	6.7	712-848	38	795	4.9	610-951
1.4	23	858	6.4	686-990	39	843	4.9	642-955	62	848	4.6	642-990
1.5	0	---	---	---	1	949	---	---	1	949	---	---
2002												
1.1	43	429	5.8	335-584	4	554	9.7	425-584	47	429	5.8	335-584
1.2	84	589	4.3	474-736	17	604	6.2	502-694	101	591	4.3	474-736
1.3	43	764	5.5	645-913	33	788	9.1	614-889	76	778	5.5	614-913
1.4	22	892	4.3	704-1,030	50	853	4.2	745-968	72	865	4.3	704-1,030
1.5	1	935	5.4	---	4	916	2.4	881-967	5	919	5.4	881-967

went down for 33 h during a high water event. Chinook salmon were not observed at the weir after 11 September. The sex composition for the season averaged 50% female, varying from 29% in late July to 60% late in the run (5 August-11 September; Table 12). Five age-classes, 1.1, 1.2, 1.3, 1.4, and 1.5, were identified from 113 of the 147 chinook salmon sampled at the weir. Age-class 1.4 was estimated to account for 56% of the sample followed by age-class 1.3 (33%; Table 13). Chinook salmon that could not be aged were not included in the analysis of age composition *(N*=34). In 2001, the MEF of chinook salmon ranged between 440 and 995 mm and about 91% of those sampled had MEF's greater than 680 mm (Figure 10). The MEF for male chinook salmon ranged from 440 to 990 mm and from 642 to 955 mm for females (Table 11). The percent of net-marked chinook salmon sampled at the weir averaged 23% (SE=2.9%), varying from 46% in mid-July (SE=8.2%) to 10% in late July (SE=5.0%; Figure 12). The percent of chinook salmon with just fungus averaged 2% (SE=1.0%) for the season, varying from 4% in late July (SE=3.1%) to 2% in August and early September (SE=2.5%; Figure 12).

Chinook Salmon 2002.-An estimated 4,791 chinook salmon migrated through the Big Creek weir in 2002 (Figure 9 and Appendix 4). Chinook salmon were first recorded at the weir on 29 June, and the peak daily escapement occurred on 17 July *(N*=1,292). Forty-seven percent of the seasons total escapement passed the weir in mid July (15-19 July). Chinook salmon were last observed at the weir on 5 September. The sex composition for the season averaged 34% female, varying from 48% in late June to 27% during mid-July (Table 14). Chinook salmon that could not be identified as male or female were not included in the analysis of sex composition *(N*=1). Five age-classes, 1.1, 1.2, 1.3, 1.4, and 1.5, were identified from 303 of the 387 chinook salmon sampled at the weir. Age-class 1.2 accounted for 37% of the sample and age-classes 1.3 and 1.4 each accounted for 22% of the sample (Table 15). Eighty-four chinook salmon that could not be aged were not included in the analysis for age composition. While the maximum MEF was greater in 2002 compare to past years, only 45.6% chinook salmon had MEF's greater than 680 mm compare to 91% in 2000 and 2001(Figure 10). The MEF for male chinook salmon ranged from 335 to 1,030 mm and from 425 to 968 mm for females (Table 11). The percent of net-marked chinook salmon averaged 4% (SE=1.0%) for the season, varying from 0% at various times during the season to a peak of 14% in early August (SE=5.2%; Figure 13). The percent of chinook salmon with just fungus varied from 0 to 5% (SE=3.1%) in mid-July. The estimated average for the entire season was less than 1% (SE=0.2%).

Coho Salmon 2000.-An estimated 969 coho salmon migrated through the Big Creek weir in 2000 (Figure 14 and Appendix 2). Coho salmon were first recorded at the weir on 28 July, and the peak daily escapement occurred on 30 August *(N*=191). Coho salmon were observed at the weir until it became inoperable on 7 September. The sex composition for the season averaged 30% female, varying from 21% in mid-August (20 August-26 August) to 31% in late August (27 August-7 September) (Table 16). One coho salmon that could not be identified as male or female was not included in the analysis of sex composition. Five age-classes, 1.1, 2.1, 2.2, 3.1, and 4.1, were identified from 197 of the 241 coho salmon sampled

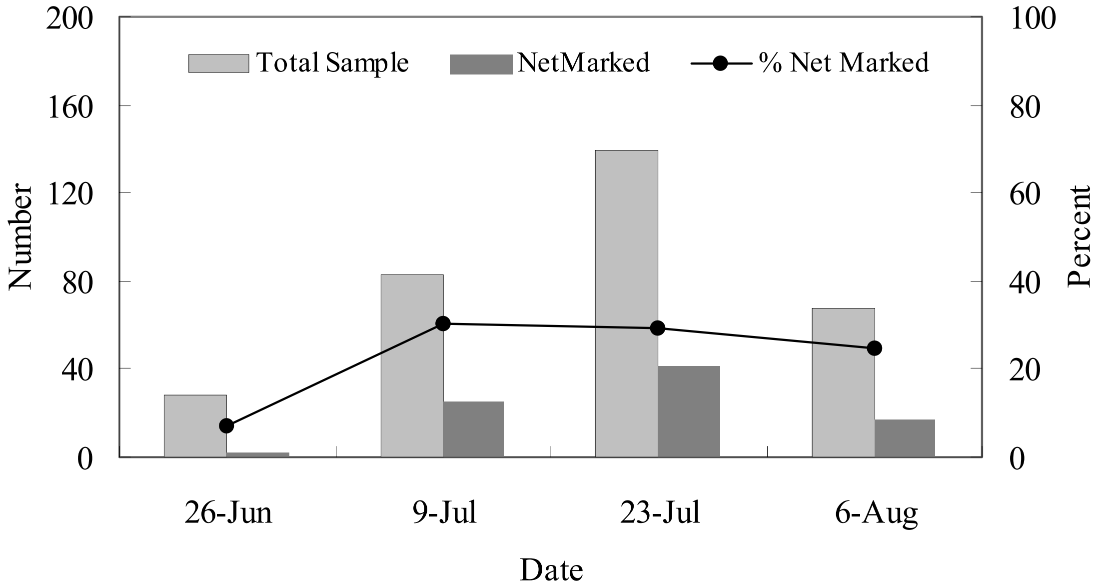

Figure 11. Number and percent of chinook salmon with gill-net marks sampled at the Big Creek weir, 2000.

Table 12. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek chinook salmon by stratum, 2001.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	% SE	Male	Female	SE	Total
Jun 24 - Jul 21	36	20	16	56	44	6.9	62	50	7.7	112
Jul 22 - Jul 28	28	20	8	71	29	7.4	75	30	7.8	105
Jul 29 - Aug 4	30	15	15	50	50	8.3	77	78	12.9	155
Aug 5 - Sep 11	53	21	32	40	60	6.1	110	167	16.9	277
Total	147	76	71	50	50	3.7	324	325	24.0	649

Table 13. Estimated age composition (percent and number) and standard errors (SE) of Big Creek chinook salmon by stratum, 2001.

						Escapement															
	Sample					1.1				1.2				1.3				1.4			
Stratum	*N*	1.1	1.2	1.3	1.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	26	3	2	7	13	11	5.6	13	6.3	8	4.7	9	5.2	27	7.8	30	8.7	50	8.8	56	9.8
2	19	0	1	10	8	0	0.0	0	0.0	5	4.8	5	5.0	53	10.7	55	11.2	42	10.5	44	11.1
3	26	0	2	12	12	0	0.0	0	0.0	8	4.9	12	7.5	46	9.1	72	14.1	46	9.1	72	14.1
4	42	0	3	9	29	0	0.0	0	0.0	7	3.7	20	10.3	22	5.9	59	16.3	69	6.7	191	18.4
Total[a]	113	3	8	38	62	2	1.0	13	6.3	7	2.3	46	14.6	33	4.0	216	25.8	56	4.2	363	27.5

[a] Sample sizes for the listed age classes do not equal the total sample size because ages 1.0 and 1.5 (*N*=2) were not included as they were <2% of the total sample.

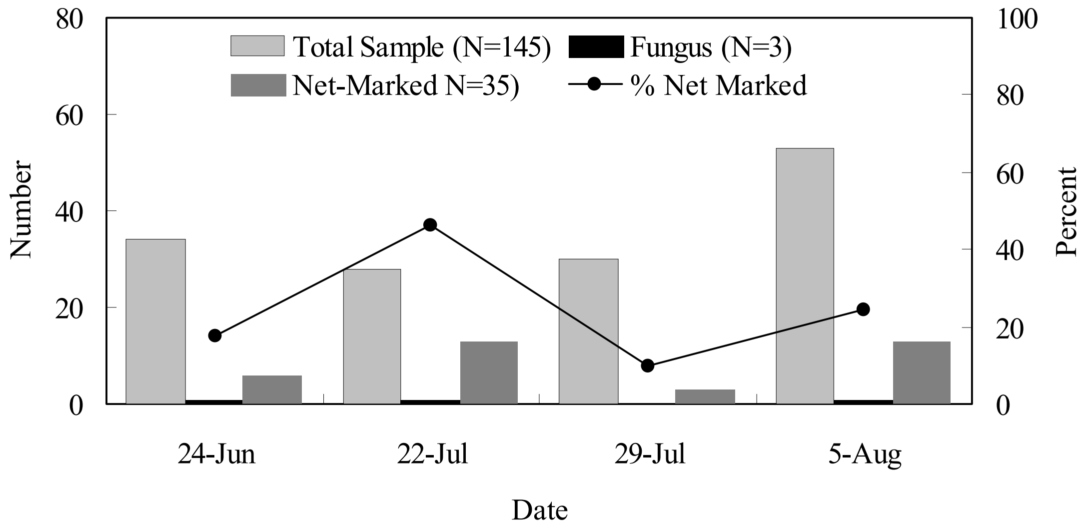

Figure 12. Number and percent of chinook salmon with gill-net marks or fungus sampled at the Big Creek weir, 2001.

Table 14. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek chinook salmon by stratum, 2002.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jun 29 - Jul 8	25	13	12	52	48	9.7	137	126	25.5	263
Jul 9 - Jul 14	84	52	32	62	38	5.2	882	542	73.6	1,424
Jul 15 - Jul 20	146	107	39	73	27	3.6	1,672	610	81.1	2,282
Jul 21 - Jul 27	42	28	14	67	33	6.3	107	54	10.2	161
Jul 28 - Aug 3	37	20	17	54	46	7.9	195	166	28.4	361
Aug 4 - Aug 10	36	24	12	67	33	7.2	124	62	13.3	186
Aug 11 - Sep 7	17	10	7	59	41	11.4	67	47	12.9	114
Total	387	254	133	66	34	2.5	3,184	1,607	117.9	4,791

Table 15. Estimated age composition (percent and number) and standard errors (SE) of Big Creek chinook salmon by stratum, 2002.

	Sample					Escapement															
						1.1				1.2				1.3				1.4			
Stratum	*N*	1.1	1.2	1.3	1.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	18	1	9	4	4	6	5.4	15	14.1	50	11.7	131	30.8	22	9.7	58	25.6	22	9.7	58	25.6
2	68	15	31	11	10	22	4.9	314	70.4	46	5.9	649	84.6	16	4.4	230	62.5	15	4.2	209	60.1
3	117	24	41	23	26	20	3.7	468	83.3	35	4.3	800	98.5	20	3.6	449	82.0	22	3.8	507	85.8
4	29	2	9	11	7	7	4.3	11	7.0	31	7.9	50	12.7	38	8.3	61	13.4	24	7.3	39	11.8
5	27	2	6	12	7	7	4.9	27	17.8	22	7.8	80	28.3	45	9.4	160	33.8	26	8.3	94	29.8
6	27	1	3	9	14	4	3.4	7	6.4	11	5.7	21	10.6	33	8.5	62	15.9	52	9.1	96	16.9
7	117	2	3	6	5	12	7.4	13	8.0	18	8.8	20	10.7	35	11.0	40	13.6	29	11.0	34	12.6
Total[a]	303	47	102	76	73	18	2.3	855	112.2	37	2.9	1,751	137.7	22	2.4	1,061	114.1	22	2.4	1,037	114.4

[a] Sample sizes for the listed age classes do not equal the total sample size because age 1.5 (N=4) were not included as they were <2% of the total sample.

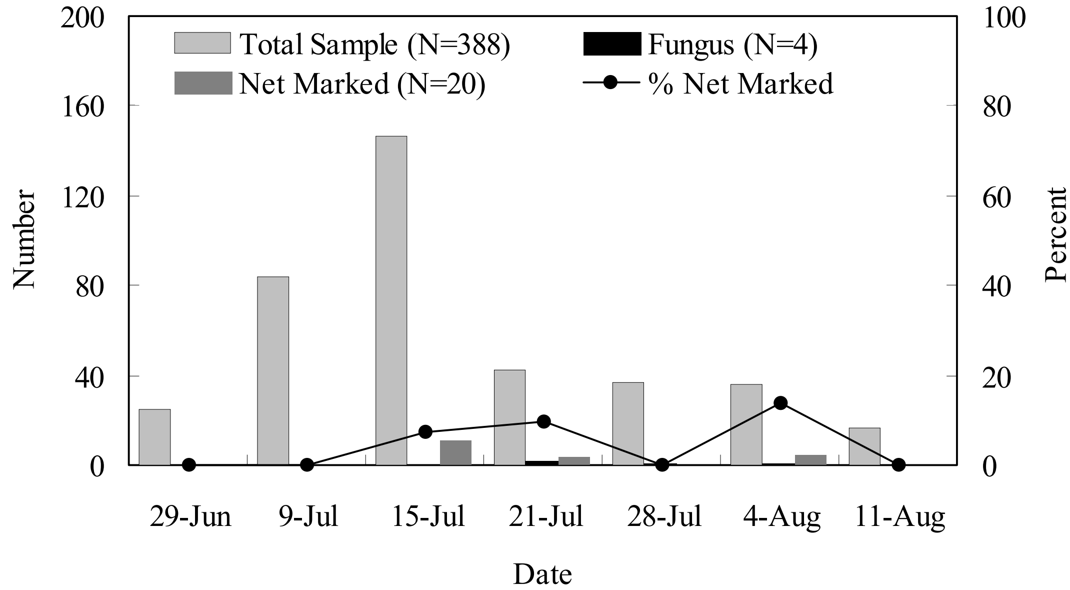

Figure 13. Number and percent of chinook salmon with gill-net marks or fungus sampled at the Big Creek weir, 2002.

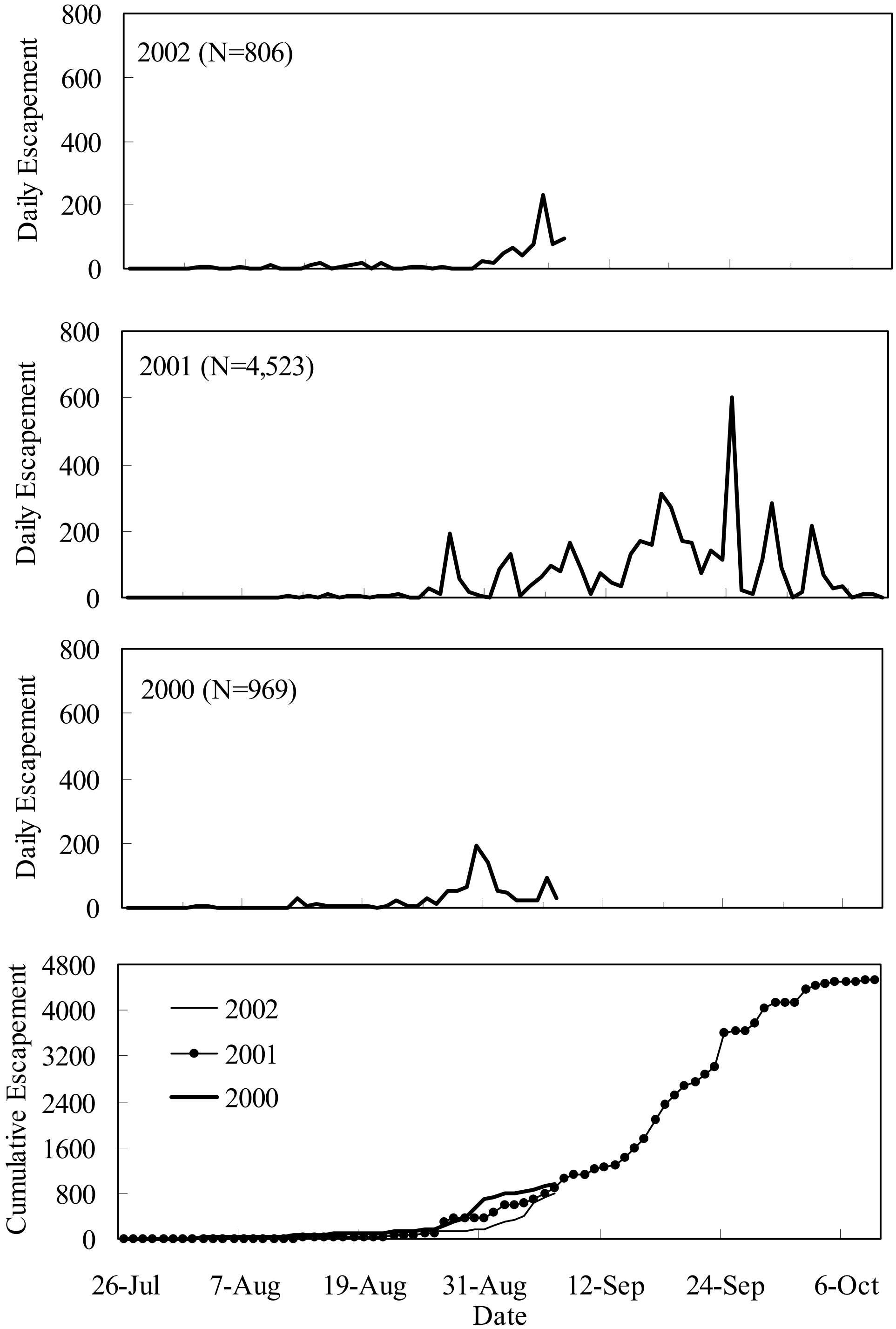

Figure 14. Daily and cumulative escapement of coho salmon through the Big Creek weir, 2000-2002.

Table 16. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek coho salmon by stratum, 2000.

	Sample			Escapement						
				Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jul 28 - Aug 19	29	21	8	72	28	7.1	73	28	7.2	101
Aug 20 - Aug 26	24	19	5	79	21	7.1	64	17	5.8	81
Aug 27 - Sep 2	137	95	42	69	31	3.5	416	184	20.8	600
Sep 3 - Sep 7	51	35	16	69	31	5.6	128	59	10.5	187
Total	241	170	71	70	30	2.6	681	288	25.1	969

Table 17. Estimated age composition (percent and number) and standard errors (SE) of Big Creek coho salmon by stratum, 2000.

	Sample				Escapement											
					1.1				2.1				3.1			
Strata	*N*	1.1	2.1	3.1	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	20	1	18	1	5	4.5	5	4.5	90	6.2	91	6.2	5	4.5	5	4.5
2	18	2	15	1	11	6.7	9	5.4	83	8.0	67	6.5	6	4.9	5	4.0
3	112	9	100	3	8	2.3	48	14.0	89	2.6	536	15.9	3	1.4	16	8.3
4	47	7	37	1	15	4.5	28	8.5	79	5.2	147	9.8	2	1.8	4	3.4
Total[a]	197	19	170	6	9	1.8	90	17.8	87	2.1	841	20.7	3	1.1	30	10.8

[a] Sample sizes for listed age classes do not equal the total sample size because ages 4.1 and 2.2 (*N*=2) were not included as they were <1% of the total sample.

at the weir (Table 17). Age-class 2.1 accounted for 87% of the sample followed by age-class 1.1 (9%) and 3.1 (3%). Forty-four coho salmon that could not be aged were not included in the analysis of age composition. In 2000, the MEF of coho salmon ranged from 457 to 672 mm, and about 50% had MEF's less than 580 mm (Figure 15). The MEF for male coho salmon ranged from 457 to 672 mm and from 499 to 660 mm for females (Table 18).

Coho Salmon 2001.-An estimated 4,523 coho salmon migrated through the Big Creek weir in 2001 (Figure 14 and Appendix 3). Coho salmon were first recorded at the weir on 4 August, and the peak daily escapement occurred on 24 September (*N*=603). Coho salmon were not observed at the weir after 9 October. The sex composition for the season averaged 50% female, varying from 26% in late August to 55% in mid-September (Table 19). One coho salmon that could not be identified as male or female was not included in the analysis of sex composition. Four age-classes, 1.1, 2.1, 2.2, and 3.1, were identified from 538 of the 646 coho salmon sampled at the weir (Table 20). Age-class 2.1 was estimated to account for 86% of the sample followed by age 1.1 (11%) and 3.1 (2%). Coho salmon that could not be aged were not included in the analysis of age composition (*N*=108). In 2001, the MEF of coho salmon ranged from 442 to 698 mm, and about 16% had MEF's less than 580 mm (Figure 15). The MEF for male coho salmon ranged from 442 to 698 mm and from 503 to 696 mm for females (Figure 15 and Table 18).

Coho Salmon 2002.-An estimated 806 coho salmon migrated through the Big Creek weir in 2002 (Figure 14 and Appendix 4). Coho salmon were first recorded at the weir on 31 July, and the peak daily escapement occurred on 5 September (*N*=234, 29% of the total escapement). Coho salmon were observed at the weir until it became inoperable on 8 September. The sex composition for the season averaged 47% female. Three age-classes, 1.1, 2.1, and 3.1, were identified from 119 of the 150 coho salmon sampled at the weir (Table 21). Age 2.1 was estimated to account for 86% of the sample followed by 1.1 (28%) and 3.1 (5%). Thirty-one coho salmon that could not be aged were not included in the analysis for age composition. In 2002, the MEF of coho salmon ranged from 472 to 744 mm, and about 27% had MEF's less than 580 mm (Figure 15). The MEF for male coho salmon ranged from 472 to 744 mm and from 526 to 657 mm for females (Table 19).

Sockeye Salmon 2000-2002.-Escapement of sockeye salmon above the Big Creek weir was less than 60 fish in all 3 years (2000: *N*=57, 2001: *N*=38, 2002: *N*=45). Sex ratios varied from 63% female in 2000 (*N*=27) to 33% female in 2001 (*N*=13). Scales were collected from sampled fish, but not aged because sample sizes were less than 30 in any year. In 2000, 8 of 27 sockeye salmon sampled at the weir had gill-net marks. The MEF for males ranged from 484 to 642 mm (*N*=10, mean=490 mm) and from 446 to 599 mm for females (*N*=17, mean=448). In 2001, 6 of 13 sockeye sampled at the weir had gill-net marks. The MEF for males ranged from 560 to 600 mm (*N*=9) and from 563 to 590 mm (*N*=2) for females. In 2002, one of the 10 (10%) sockeye salmon sampled at the weir had gill net marks, and the MEF for all fish ranged from 463 to 628 mm.

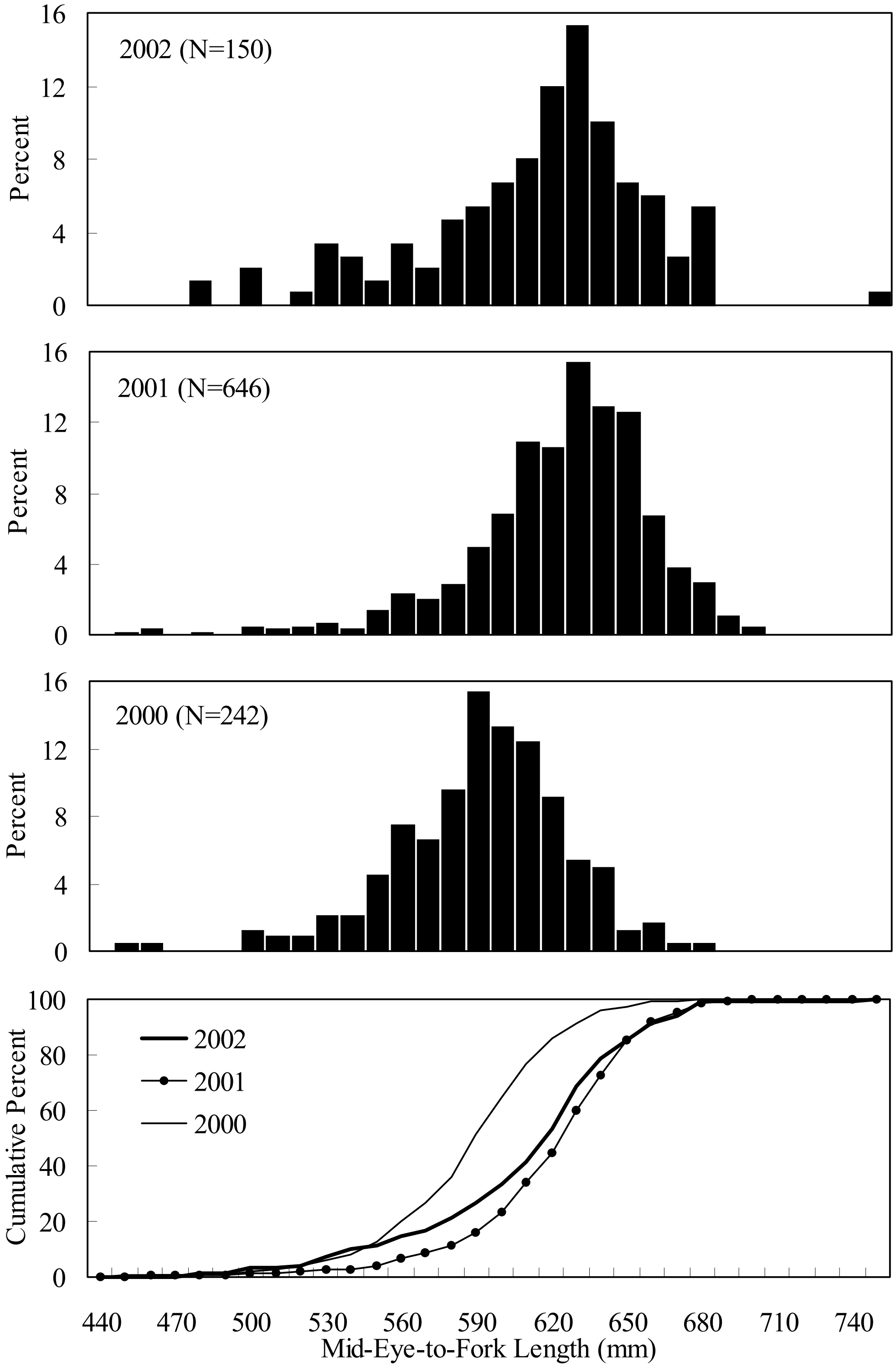

Figure 15. Length frequency and cumulative length frequency for coho salmon sampled at the Big Creek weir, 2000-2002.

Table 18. Estimated length composition (sample size, mean, standard error, and range) of Big Creek coho salmon by age and sex, 2000-2002. All lengths are mid-eye to fork-of-tail (mm).

	Males				Females				All Fish			
Age	*N*	Mean	SE	Range	*N*	Mean	SE	Range	*N*	Mean	SE	Range
						2000[a]						
1.1	14	580	3.7	521-640	5	575	6.3	552-595	19	579	3.6	521-640
2.1	121	595	3.3	457-672	48	586	4.0	499-660	170	593	3.5	457-672
3.1	3	607	7.5	555-640	3	599	18.3	575-600	6	598	6.4	555-640
4.1	1	571	---	---	0	---	---	---	1	571	---	---
2.2	1	614	---	---	0	---	---	---	1	614	---	---
						2001[a]						
1.1	32	610	3.7	525-666	30	612	3.3	548-654	62	611	2.8	525-666
2.1	228	619	2.8	442-698	231	619	2.4	503-696	460	619	2.6	442-698
3.1	6	638	5.2	608-665	8	606	9.8	520-640	14	621	5.4	520-665
2.2	0	---	---	---	2	577	---	548-605	2	577	---	548-605
						2002						
1.1	15	585	15.5	472-643	12	599	8.8	536-635	27	591	9.4	472-643
2.1	46	618	7.2	498-744	41	615	4.2	526-657	87	616	4.3	498-744
3.1	3	665	14.7	636-680	2	584	16.0	568-600	5	633	22.1	568-680

[a] All fish includes fish that were not identified as male and female.

Table 19. Estimated sex composition (percent and number) and standard errors (SE) of Big Creek coho salmon by stratum, 2001.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Aug 4 - Aug 25	22	14	8	64	36	9.1	58	33	8.3	91
Aug 26 - Sep 1	38	28	10	74	26	6.9	273	98	25.4	371
Sep 2 - Sep 8	74	38	36	51	49	5.5	298	283	31.8	581
Sep 9 - Sep 15	125	62	63	50	50	4.0	276	280	22.0	556
Sep 16 - Sep 22	162	73	89	45	55	3.7	583	711	47.5	1,294
Sep 23 - Sep 29	161	75	86	47	53	3.7	577	661	45.5	1,238
Sep 30 to Oct 13	63	29	34	46	54	5.8	181	211	22.7	392
Total	645	319	326	50	50	1.9	2,246	2,277	84.0	4,523

Table 20. Estimated age composition (percent and number) and standard errors (SE) of Big Creek coho salmon by stratum, 2001.

					Escapement											
	Sample				1.1				2.1				3.1			
Strata	*N*	1.1	2.1	3.1	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	20	2	16	2	10	6.1	9	5.5	80	8.1	73	7.4	10	6.1	9	5.5
2	30	2	26	1	7	4.4	25	16.5	87	6.1	322	22.5	3	3.2	12	11.9
3	63	4	58	1	6	2.9	37	17.0	92	3.2	535	18.8	2	1.5	9	8.7
4	102	15	83	3	15	3.2	82	17.7	81	3.5	452	19.5	3	1.5	16	8.4
5	142	19	119	4	13	2.7	173	35.0	84	2.9	1,084	37.9	3	1.3	37	17.0
6	130	14	114	2	11	2.6	133	32.0	88	2.7	1,086	33.9	1	1.0	19	12.7
7	51	6	44	1	12	4.2	46	16.7	86	4.5	338	17.8	2	1.8	8	7.2
Total[a]	538	62	460	14	11	1.3	505	58.6	86	1.4	3,890	64.7	2	0.6	110	28.6

[a] Sample sizes for listed age classes do not equal the total sample size because age 2.2 (*N*=2) was not included as it was <1% of the total sample.

Table 21. Estimated age composition (percent and number) and standard errors (SE) of Big Creek coho salmon, 2002.

Age	*N*	%	SE	No.	SE
1.1	28	24	3.6	190	29.1
2.1	86	72	3.8	582	30.7
3.1	5	4	1.7	34	13.7

Pink Salmon 2000-2002.-Escapement of pink salmon through the Big Creek weir was less than 100 fish in all 3 years (2000: *N*=80, 2001: *N*=15, 2002: *N*=31). However, picket spacing appeared to allow small pink salmon to pass upstream of the weir without being counted. The number of pink salmon sampled at the weir was less than 10 in any year; therefore, no sex ratio or length data is reported.

Resident Species 2000-2002.-In 2000, several resident species were recorded migrating through the weir, including Dolly Varden *(N*=24), Arctic grayling *(N*=2), northern pike *(N*=2), rainbow trout *(N*=2), round whitefish *(N*=4), and longnose sucker *(N*=1). In 2001, Dolly Varden *(N*=21), rainbow trout *(N*=11), and Arctic grayling *(N*=1) were captured in the trap box. Northern pike and round whitefish were also observed at the weir, but were not captured in the trap box. In 2002, Dolly Varden *(N*=347), rainbow trout *(N*=24), round whitefish *(N*=16), Arctic grayling *(N*=3), northern pike *(N*=1), and 34 unknown resident species passed through the weir either through the trap box or video chute. The picket spacing on the weir allowed most resident species to pass through the weir; therefore, mean fork length was not calculated for any species.

Public Use Survey

Public Use 2000.-Twenty-six groups visiting the Refuge were interviewed at the Big Creek weir from 4 July to 13 September (Table 22). All groups accessed the Refuge by boat *(N*=29 boats). Fishing was the primary purpose for 15 groups, followed by hunting (8 groups) and site seeing (3 groups). Of the 26 groups, only 4 groups had a secondary purpose for visiting the refuge (e.g., fishing or site seeing). Of the 15 groups fishing on the Refuge, 10 were targeting primarily rainbow trout. Nine groups were targeting more than one fish species including rainbow trout, Dolly Varden, Arctic grayling, and various salmon species. The known harvest for groups fishing upstream or near the Big Creek weir was 3 chinook salmon, 3 rainbow trout, 1 Arctic grayling, and 3 chum salmon. Of the eight groups hunting on the Refuge seven were targeting moose and five were targeting brown bear. Four groups were hunting for both moose and bear. The known harvest for groups hunting on Big Creek was one bear and one moose. Eighteen of the groups were not guided, seven groups were guided, and one group had unknown guide status.

Table 22. Summary of 2000 public use information collected at the Big Creek weir including, primary purpose, secondary purpose, target species (hunting and fishing), guide status, reason for visit, and residence. Some groups had multiple target species (*N*=13) and/or residence (*N*=4).

Category	Number of Groups
Primary Purpose	
Hunting	8
Fishing	15
Other (Site seeing)	3
Secondary Purpose	
Hunting	0
Fishing	2
Other	2
Hunting Target Species	
Moose	7
Bear	5
Small Game	0
Fishing Target Species	
Rainbow Trout	10
Coho Salmon	1
Dolly Varden	2
Arctic Grayling	8
Chinook	1
Salmon	2
Guide Status	
Guided	7
Not Guided	18
Unknown	1
Reason for Visit	
Sport	24
Subsistence	0
Other	2
Residence	
King Salmon	12
Naknek	6
Other Alaska	0
Lower 48 States (TN, CO, NC, and MS)	3
International (France, Switz., Belgium, and Spain)	7
Unknown	2

Twenty-four of the 26 groups were hunting or fishing for sport rather than subsistence. King Salmon and Naknek were the two primary residences for visitors interviewed at the Big Creek weir. There were 18 groups with one or more people from King Salmon or Naknek. Seven groups had at least one person with an international residence (i.e., France, Switzerland, Belgium, and Spain), three groups had people from the contiguous 48 states, and the residence for two groups were unknown. Four groups had residents from two or more residence categories.

The average time each group spent fishing was 3.3 h/group and 43.9 h/group for those hunting (Table 23). The total time spent on the refuge by all groups interviewed was about 402 h. The total expanded time (i.e., time*group size) for all groups was about 1,506 h. Of the groups interviewed, the average size of groups hunting was three people, with a total of 25 people hunting. The average size for groups fishing was also three people, but there were more people fishing (N=47). The groups whose primary purpose for visiting the refuge was something other than fishing or hunting were a small portion of all groups interviewed at the weir (N=3). The average size of all groups was 4.3 people, with a total of 13 people engaged in activities other than hunting and fishing. Twenty-three people fishing on Big Creek were interviewed to identify target species and determine catch rates. Their target species included chinook and chum salmon, rainbow trout, Dolly Varden, and Arctic grayling. The average catch rate for all species was 1.4 fish/h (SD=1.2, range = 0 to 9 fish, N=23). The average time spent fishing was 5.1 h (SD=2.2 hours, range = 2 to 8.5 h, N=23).

Public Use 2001.-Forty-six groups visiting the Refuge were interviewed at the weir from 21 June to 7 October 2001 (Table 24). With the exception of two groups which accessed the Refuge by helicopter, all other groups accessed the Refuge by boat. Hunting was the primary purpose for 33 groups, followed by fishing (9 groups) and site seeing (4 groups). Of the 33 groups hunting on the Refuge, 23 were targeting moose, 9 were targeting bear, and 3 were targeting birds or small game. However, four groups were targeting more than one species (i.e., mammal or fish). The known harvest for groups hunting was four moose. Of the nine groups fishing on the Refuge, five were targeting more than one species of fish (e.g., rainbow trout, Arctic grayling, and various salmon species) or also hunting. Thirty of the groups visiting the Refuge were not guided, 15 groups were guided, and one group had unknown guide status. Forty-one of the groups were hunting or fishing for sport, one was hunting for subsistence, and four were site seeing. King Salmon and Naknek were the two primary residences for visitors interviewed at the Big Creek weir. There were 33 groups with one or more people from King Salmon or Naknek. Six groups had at least one person with an international residence, seven groups had people from the contiguous 48 states, and the residence for five groups were unknown. Seven groups had residents from two or more residence categories, and five other groups whose residence was listed as King Salmon were guided; therefore, residence of all individuals may not be King Salmon.

The average time each group spent fishing was 2.9 h/group and 39.4 h/group for those hunting (Table 25). The total time spent on the refuge by all groups interviewed was about

Table 23. Summary of 2000 public use information (time spent in an activity and group size) collected at the Big Creek Weir by primary purpose (hunting, fishing, other, and all).

	Primary Purpose for Visit			
	Hunting	Fishing	Other	All
Groups Interviewed (N)	8	15	3	36
Complete Surveys	7	13	1	21
Incomplete Surveys	1	2	2	5
Time Spent in Activity[a]				
Total Time for all Groups (hrs)	351.3	46.4	4.5	402.2
Average Time Per Group (hrs)	43.9	3.3	4.5	17.5
SD	92.9	2.4	---	56.0
Range (hrs)	4-273	1-9.5	---	1-273
N	8	14	1	23
Group Information				
Total Number of People	25	47	13	85
Average Group Size (hrs)	3.1	3.1	4.3	3.3
SD	0.6	2.0	2.1	1.7
Range (hrs)	2-4	2-10	2-6	2-10
N	8	15	3	26
*Expanded Time (time*group size) (hrs)*	1,346.3	132.9	27	1,506.2

[a] To determine total time for groups that spent more than a day on the Refuge, 24 hrs was used for a complete day on the Refuge.

Table 24. Summary of 2001 public use information collected at the Big Creek weir including, primary purpose, secondary purpose, target species (hunting and fishing), guide status, reason for visit, and residence. Some groups had multiple target species *(N*=7) and/or residence *(N*=9[a]).

Category	Number of Groups
Primary Purpose	
Hunting	33
Fishing	9
Other (Site seeing)	4
Secondary Purpose	
Hunting	1
Fishing	3
Other	1
Hunting Target Species	
Moose (4 harvested)	23
Bear	9
Birds	1
Small Game	2
Fishing Target Species	
Rainbow Trout (38 caught and released)	4
Arctic Grayling (7 caught and released)	3
Coho Salmon	5
Chinook Salmon (2 caught and released)	1
Trout	1
Guide Status	
Guided	15
Not Guided	30
Reason for Visit	
Sport	41
Subsistence	1
Other	4
Residence	
King Salmon	31[a]
Naknek	6
Other Alaska	0
Lower 48 States (AR, NC, MI, MD, WI, and TX)	7
International (Belgium, Switz, France, and Australia)	6
Unknown	5[a]

[a] Five groups whose residence was listed as King Salmon were guided; therefore residence may not be King Salmon.

Table 25. Summary of 2001 public use information (time spent in an activity and group size) collected at the Big Creek Weir by primary purpose (hunting, fishing, other, and all).

	Primary Purpose for Visit			
	Hunting	Fishing	Other	All
Groups Interviewed (N)	33	9	4	46
Complete Surveys	23	8	4	35
Incomplete Surveys	10	1	0	11
Time Spent in Activity[a]				
Total Time for all Groups (hrs)	944.5	45	10.5	1,000
Average Time Per Group (hrs)	39.4	5	2.6	27.0
SD	69.3	3.3	2.2	61.3
Range (hrs)	1.5-255.5	0.5-9.5	0.5-4	0.5-255.5
N	24	9	4	37
Group Information				
Total Number of People	86	26	14	126
Average Group Size (hrs)	2.7	2.9	3.5	2.8
SD	0.9	1.2	1.7	1.0
Range (hrs)	1-4	1-5	2-6	1-6
N	32	9	4	45
*Expanded Time (time*group size) (hrs)*	2,289	149	46	2,484

[a] To determine total time for groups that spent more than a day on the Refuge, 24 hrs was used for a complete day on the Refuge.

1,000 h. The total expanded time (i.e., time*group size) for all groups was about 2,484 h. Of the groups interviewed, the average size for groups hunting was 2.7 people, and there was a total of 86 people hunting. The average size for groups fishing was 2.9 people, and there was a total of 26 people fishing. Groups whose primary purpose for visiting the refuge was something other than fishing or hunting were a small portion of all groups interviewed at the weir *(N*=4). The average size of these groups was 3.5 people, and there was a total of 14 people engaged in activities other than hunting and fishing.

Public Use 2002.-Twenty-three groups visiting the Refuge were interviewed at the weir from 14 July to 9 September 2002 (Table 26). All groups accessed the Refuge by boat. Hunting was the primary purpose for 12 groups, followed by fishing (6 groups) and site seeing (5 groups). Ten groups had a secondary purpose for visiting the Refuge (e.g., fishing or other). Of the 12 groups hunting on the Refuge, 7 were targeting moose, 2 were targeting bear, and 4 were targeting small game. However, four groups were targeting more than one species (i.e., fish or mammal). Of the six groups fishing on the Refuge, three were targeting more than one species of fish (e.g., rainbow trout, Arctic grayling, and chinook, coho and other salmon species) or also hunting. Nineteen of the groups visiting the Refuge were not guided, three groups were guided, and one group had unknown guide status. Eighteen of the groups were hunting or fishing for sport rather than subsistence and five were site seeing. King Salmon and Naknek were the two primary residences for visitors interviewed at the Big Creek weir. There were 18 groups with one or more people from King Salmon or Naknek. Two groups had at least one person with an international residence, one group had a resident from Anchorage, and the residence for two groups were unknown.

The average time each group spent fishing was 5.4 h/group and 17.1 h/group for hunting (Table 27). The total time spent on the refuge by all groups interviewed was about 177 h. The total expanded time (i.e., time*group size) for all groups was about 376 h. Of the groups interviewed, the average size of groups hunting was 2.2 people, and there was a total of 26 people hunting. The average size of groups fishing was 2.3 people, and there was a total of 14 people fishing. Five groups (18 people) whose primary purpose for visiting the refuge was something other than fishing or hunting were interviewed at the weir.

Discussion

Weir Operation

In 2000, the fixed-picket weir performed well until 7 September, and provided good estimates of escapement for chinook and chum salmon. More pink salmon were observed upstream of the weir than had been counted, so it appears that small pink salmon were able to pass between pickets. In addition, there were two high-water events in July and August when portions of the weir were opened for 8-11 h to prevent a blow out. It is likely that some fish were not counted during these high water events. However, less than 210 chum and 160 chinook salmon had migrated through the weir prior to the first high water event, and more

Table 26. Summary of 2002 public use information collected at the Big Creek weir including, primary purpose, secondary purpose, target species (hunting and fishing), guide status, reason for visit, and residence. Some groups had multiple target species (*N*=7) and/or reason (*N*=2).

Category	Number of Groups
Primary Purpose	
Hunting	12
Fishing	6
Other (Site seeing)	5
Secondary Purpose	
Hunting	0
Fishing	6
Other	4
Hunting Target Species	
Moose	7
Bear	2
Small Game	4
Fishing Target Species	
Rainbow Trout	7
Coho Salmon	1
Dolly Varden	2
Unknown	2
Guide Status	
Guided	3
Not Guided	19
Unknown	1
Reason for Visit	
Sport	18
Subsistence	2
Other	5
Residence	
King Salmon	15
Naknek	3
Other Alaska (Anchorage)	1
Lower 48 States	0
International (France)	2
Unknown	2

Table 27. Summary of 2002 public use information (time spent in an activity and group size) collected at the Big Creek Weir by primary purpose (hunting, fishing, other, and all).

	Primary Purpose for Visit			
	Hunting	Fishing	Other	All
Groups Interviewed (N)	12	6	5	23
Complete Surveys	8	3	5	16
Incomplete Surveys	4	3	0	7
Time Spent in Activity[a]				
Total Time for all Groups (hrs)	136.5	21.5	19.3	177.3
Average Time Per Group (hrs)	17.1	5.4	3.9	10.4
SD	15.9	1.5	2.6	12.4
Range (hrs)				
N	8	4	5	17
Group Information				
Total Number of People	26	14	18	58
Average Group Size (hrs)	2.2	2.3	3.6	2.5
SD	0.7	1.0	1.8	1.2
Range (hrs)				
N	12	6	5	23
*Expanded Time (time*group size) (hrs)*	240	51	84.5	375.5

[a] To determine total time for groups that spent more than a day on the Refuge, 24 hrs was used for a complete day on the Refuge.

than 90% of the estimated escapement for both species had migrated prior to the second high-water event. Therefore, the estimated escapement of chinook and chum salmon through the weir should reflect the actual escapement. The ADF&G aerial survey conducted on 7 August 2000 estimated 885 chinook salmon above the weir and 227 below (Steve Morstad, ADF&G, personal communication). The cumulative weir escapement to date when the survey was conducted, was 1,044 chinook salmon. Estimates from the aerial surveys did not indicate that we had undercounted the number of chinook salmon migrating through the weir. Since the weir became inoperable after 7 September and the coho salmon migration had not ended, the coho salmon counts underestimated the actual escapement.

In 2001, chinook and chum salmon escapement estimates at the weir were low. The ADF&G aerial survey conducted 8 August estimated 1,734 chinook and 12,000 chum salmon above the weir (Steve Morstad, ADF&G, personal communication). The cumulative chinook and chum salmon escapement at the weir on the day of the survey was 512 and 9,416 fish respectively. The discrepancy between the two estimates indicates that a large number of fish escaped upstream without being counted. One possibility is that the weir was not fish tight early in the season. Another possibility is that a large number of fish migrated past the weir during two high-water events that occurred on 13 and 23-24 July. The entire weir was down for about 10 h on 13 July and 33 h on 23-24 July. On 13 July the stage height was the highest to that date (0.5 m), but not the highest for the season (0.9 m). However, on 23 July, the estimated discharge (20.9 m^3/sec) was higher than levels in September 2000 when the weir became inoperable (17.9 m^3/sec). Increasing flows are known to stimulate upstream migration in salmon (Groot and Margolis 1991). In 2000 and 2002, approximately 50% of the chinook salmon migration through the weir occurred during a 3 to 4-d period. Water levels during those periods were normal. In addition, while the date of peak escapement varied between years for both chum and chinook salmon in 2000 and 2001, both species escapement peaked on the same day. In 2001, the peak chum salmon escapement occurred on 19 July which was 4 days prior to the high water event on 23 July.

In 2001, the fixed-picket weir was replaced on 15 August with a modified resistence-board weir. It is possible that some fish were not counted during installation, or some fish were counted twice because the fixed-picket weir was removed about 2 h before the resistence board weir was fish tight. However, water levels were near the lowest levels for the season (i.e., stage height=0.3 m), and the weekly chum and chinook salmon escapement estimates were about 25 to 30% of the escapement estimated during the previous week. Even though some fish might have migrated past the study site when changing weirs, it is unlikely that a large number of fish were missed or counted twice. In 2001, high flows in early September and October submerged the resistence board weir. When the panels were submerged, some fish were observed swimming over the weir in September, but not in October. The peak coho salmon escapement occurred in mid-September, so it is likely that some escaped upstream without being counted during high water events. Although the floating weir was not completely fish tight during high water events in 2001, this type of weir allowed us to obtain a more complete count of coho salmon than in 2000. Accurate estimates of coho salmon in Big Creek are important, because there are no historical escapement data available.

In 2002, the redesigned floating weir (i.e., V-shaped) performed well most of the season, but there were times when it was not fish tight. Early in the season, damage to the trap box may have allowed some fish to migrate past the weir uncounted. In addition, high numbers of chum and chinook salmon migrated through the weir shortly after the weir was installed indicating that we may have missed some fish prior to installation. Cumulative weir escapement estimates at the weir on 2 August were 4,480 chinook and 25,693 chum salmon, and aerial surveys estimated 1,640 chinook and 15,000 chum salmon above the weir(Steve Morstad, ADF&G, personal communication). Aerial counts are often inaccurate because they are dependent upon a variety of factors (e.g., wind, water clarity, etc.). However, the aerial count conducted by ADF&G on Big Creek is only an index of escapement. A high water event damaged the trap box on 7 September making it inoperable; therefore, the weir was removed prior to the end of the coho salmon run and escapement estimates at the weir likely underestimate the actual escapement.

Biological Data

Chum salmon escapement was much lower in 2000 than 2001 and 2002, but reasons for differences cannot be explained by differences in weir operations. Rather the differences are likely related to biological or environmental factors. In 2000, the chum salmon commercial harvest was well below average in the Naknek/Kvichak District as well as the Bristol Bay region, despite fishing effort was similar to previous years (ADF&G 2001). In 2001, the chum salmon escapement estimate at the weir was more than 360% higher than estimated in 2000, but the ADF&G aerial survey indicated the actual escapement was higher than the weir estimate indicated. The 2001, commercial harvest of chum salmon in Bristol Bay was the highest since 1995, but harvest in the Naknek/Kvichak District, was still less than half of the 10-yr average (ADF&G 2002). In 2002, chum salmon harvest in the commercial fishery was much lower (11,879) than the 20-year average of 230,754 fish, but escapement at the Big Creek weir (28,812) was much higher than in 2000 and 2001. The first scheduled opening in the commercial fishery that year, occurred on 28 June, 15 d later than the first opening in 2001, and 27 d later than in 2000 (Steve Morstad, ADF&G, personal communication; ADF&G 2001; ADF&G 2002). In addition, fishing effort during most years of the commercial fishery slows down after 17 July, but in 2002 most fishermen stopped fishing by 8 July. The delay in the opening of the commercial fishery and early departure of fisherman may have allowed more chum salmon to reach the spawning grounds.

Chum salmon run timing in 2002 appeared to be earlier than 2000 and 2001 run timing. Peak escapement in 2002 occurred only 2 d earlier than in 2001, but in 2002 about 48% of the total escapement occurred prior to the peak escapement (17 July) whereas in 2001, only 17% of the total escapement occurred prior to the peak escapement (19 July). In 2000, the peak escapement occurred on 3 August, and 30% of the total escapement occurred prior to the peak escapement. Without additional data, it is not possible to know which year represents the average run timing for chum salmon. Aerial surveys provide the only other escapement data for Big Creek, and chum salmon were not counted in most years (Browning et al. 2002).

Chum salmon sex ratios at the Big Creek weir were heavily skewed toward males in 2000 (68%) and 2001 (73%). In 2002, sex ratios were still skewed toward males (57%), but less than the first 2 years. One possible reason for the skewed sex ratios was gear selection in the commercial fishery. However, the sex of chum salmon harvested in the Naknek/Kvichak fishery is not available to verify this conclusion. The delayed opening of the commercial fishery and early departure of commercial fisherman may account for differences in sex ratios seen between years at the Big Creek weir.

The age composition of chum salmon in Big Creek was similar to other populations in western Alaska (Price and Larson 1999; Wiswar 2001; Gates and Harper 2002), but appears to be influenced by the commercial fishery. Chum salmon age-class 0.3 and 0.4 were the most abundant in all 3 years, but abundance varied between years. In 2000, the abundance of age-class 0.3 and 0.4 was similar (38%), but in 2001 age-class 0.3 was 93% of the chum sampled at the weir, while in 2002, age-class 0.4 was 62% of the chum salmon sampled at the weir. One possible reason for a higher abundance of age 0.4 chum could be a combination of good ocean survival and the delayed opening in the commercial fishery. Older fish often return earlier than younger fish (Salo 1991). In 2000 and 2002, age 0.4 chum were the most abundant age-class sampled at the weir until late July, but in 2001 they were only abundant (45%) very early in the run (24 June to 7 July). The high percentage of chum salmon with gill-net marks early in the season likely correlates to effort and catch rates in the commercial fishery which usually peaks around 3 to 4 July (Steve Morstad, ADF&G, personnel communication). Lower numbers of gill-net marked chum in 2002 may be explained by the delayed opening and reduced effort at the end of the commercial season.

Chinook salmon escapement estimates at the Big Creek weir were higher in 2002 than in 2000 and 2001 despite problems with weir damage early in the season. In addition, the peak escapement in 2002 occurred 2 to 3 weeks earlier than in 2000 and 2001. In fact, 91-93% of the total escapement in 2002 had occurred prior to the dates of a peak escapement in 2000 and 2001. However with only 3 years of data, it is not possible to determine which year represents the average timing for chinook salmon in Big Creek. Aerial surveys provide the only other escapement data available for Big Creek. Surveys are flown during the estimated peak spawning and are only escapement index counts (Browning et al. 2002). Changes in the commercial fishery may have influenced the apparent change in run timing. With the opening delayed until late June, more chinook salmon may have been able to migrate upstream prior to the commercial fishery.

Female chinook salmon were more abundant than males in 2000 (61%), but in not in 2002 (34%). In addition, a comparison of the length frequency graphs for all 3 years indicate a significant difference between chinook salmon sampled in 2002 and those sampled in 2000 and 2001. Chinook salmon 330-680 mm in length were more abundant in 2002, and a large portion of these smaller fish were males. In addition, many of these smaller fish were captured at the weir early in the season. The delayed opening in the commercial fishery in 2002 may account for these differences. Often males are more predominant early in the run. Chinook salmon that are 330 to 680 mm in length are similar in size to chum and sockeye salmon captured with gill net mesh sizes less than 14 cm. It is possible that during 2000 and 2001, many of these smaller males were captured in the commercial fishery, but with a delayed opening in 2002, more were able to reach the spawning grounds. Mesh size restrictions (<14 cm) during the emergency order were implemented in the mid-90's to protect large chinook salmon in the Naknek drainage (ADF&G 2002). Unfortunately, this does not explain why the percent of females were so low in 2002, unless these fish were more vulnerable to subsistence nets and/or targeted preferentially by sport fishermen.

The delayed opening in the commercial fishery may also explain the large increase in age 1.1 and 1.2 chinook salmon in 2002. Often male chinook salmon will be more abundant early in the run and dominate the younger age categories (Healy 1991), which was supported by age composition data collected in 2002. Eighty-six percent of the age-classes 1.1 and 1.2 were males. Prior to mid-July in 2002, the percent of chinook salmon that were age 1.1 (6-22%) and 1.2 (35-50%) was higher than in 2000 (age 1.1: 3-5%; age 1.2: 11-34%) and 2001 (age 1.1: 0-11%; age 1.2: 5-8%). Changes in picket spacing may have also influenced the size composition of chinook salmon, but is unlikely. When the fixed-picket weir was replaced in 2001 with the floating weir, a few fish were observed squeezing between pickets. However, it is unlikely that many chinook salmon bypassed the weir in this manner, because 86% of the escapement migrated prior to the installation of the floating weir on 15 August 2001 and most small males tend to migrate early in the run. To reduce the likelihood of fish squeezing between pickets, in 2002 picket spacing on the floating weir was reduced and additional stringers installed to increase the rigidity of the weir.

Coho salmon escapement was much higher in 2001 than the other 2 years, but the difference can likely be explained by the early removal of the weir in 2000 and 2002. Installing a modified resistence board weir has increased our ability to maintain the weir during high flows in September and October and should provide better coho salmon counts in the future. Removal of the weir prior to the end of the run likely also accounts for differences in sex ratio between years. Despite the early removal, the coho salmon age composition was similar to other studies conducted on the Alaska Peninsula and in western Alaska (i.e., age 2.1 was predominant usually followed by age 1.1; Price and Larson 1999; West and Gray 2001; Edwards and Larson 2002).

Sockeye and pink salmon populations in Big Creek were small for all three years; therefore, little information was collected from those sampled at the weir. Resident species comprised a small portion of all fish passing the weir. However, the installation of a video chute in 2002 appears to have improved our ability to enumerate those passing the weir. Dolly Varden in particular, were more abundant in 2002 than the other 2 years. In 2000 and 2001 the picket spacing allowed most resident species to pass through the weir without being counted, but in 2002, the weir spacing was reduced slightly and may also account for the increased numbers of resident species captured or passed at the weir.

The public use survey conducted on Big Creek was opportunistic, and therefore, is not a complete census of all visitors to Big Creek or the Refuge. In 2000, all boats passing the weir had to stop while weir crews opened the boat gate; therefore, these groups were likely interviewed at least once. In August 2001, the fixed-picket weir was replaced with a resistence-board weir that allowed boaters to motor over the weir without assistance. Consequently, many boaters did not stop on their way downstream. The number of interviews varies between years, but likely does not indicate a trend in visitation to the Refuge or Big Creek . It could also be a reflection of the number of boaters contacted each season. In other words, the decline in 2002 may just indicate a decline in the number of groups interviewed.

Conclusion

The variability among years in escapement for most species suggests that operating the weir on Big Creek for more than 3 years is necessary to determine what is an average escapement. High water was an issue during all 3 years, and consequently weir counts were not complete in any year, but modifications to the weir have improved our ability to obtain more accurate counts. Operating the Big Creek weir for additional years will provide escapement and biological data that may be important for managing sport, commercial, and subsistence fisheries in the Naknek River. Big Creek provides important spawning habitat for chinook and coho salmon which in addition to rainbow trout, are the primary targets in the large Naknek River sport fishery. Limited escapement information is available for coho salmon in the Naknek drainage; therefore, collecting information from Big Creek will significantly benefit management.

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Appendix 1. Strata (time periods) used for analysis of Big Creek chinook, chum, and coho salmon biological data, 2000 - 2002.

Stratum	Chinook Salmon	Chum Salmon	Coho Salmon
		2000	
1	Jun 24 to Jul 15	Jun 24 to Jul 1	Jul 28 to Aug 19
2	Jul 16 to Jul 29	Jul 2 to Jul 15	Aug 20 to Aug 26
3	Jul 30 to Aug 5	Jul 16 to Jul 22	Aug 27 to Sep 2
4	Aug 6 to Aug 12	Jul 23 to Jul 29	Sep 3 to Sep 7
5	Aug 13 to Sep 7	Jul 30 to Aug 5	-----
6	-----	Aug 6 to Aug 12	-----
7	-----	Aug 13 to Aug 19	-----
8	-----	Aug 20 to Sep 7	-----
		2001	
1	Jun 24 to Jul 21	Jun 24 to Jul 7	Aug 4 to Aug 25
2	Jul 22 to Jul 28	Jul 8 to Jul 14	Aug 26 to Sep 1
3	Jul 29 to Aug 4	Jul 15 to Jul 21	Sep 2 to Sep 8
4	Aug 5 to Sep 11	Jul 22 to Jul 28	Sep 9 to Sep 15
5	-----	Jul 29 to Aug 4	Sep 16 to Sep 22
6	-----	Aug 5 to Aug 11	Sep 23 to Sep 29
7	-----	Aug 12 to Aug 18	Sep 30 to Oct 13
8	-----	Aug 19 to Aug 25	-----
9	-----	Aug 26 to Oct 2	-----
		2002	
1	Jun 29 to Jul 8	Jun 29 to Jul 6	Jul 31 to Sep 7
2	Jul 9 to Jul 14	Jul 7 to Jul 13	-----
3	Jul 15 to Jul 20	Jul 14 to Jul 20	-----
4	Jul 21 to Jul 27	Jul 21 to Jul 27	-----
5	Jul 28 to Aug 3	Jul 28 to Aug 3	-----
6	Aug 4 to Aug 10	Aug 4 to Aug 10	-----
7	Aug 11 to Sep 7	Aug 11 to Aug 17	-----
8	-----	Aug 18 to Sep 7	-----

Appendix 2. Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of chum, chinook and coho salmon escapement through the Big Creek weir, 2000.

	Chum Salmon			Chinook Salmon			Coho Salmon		
Date	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
24-Jun	0	0	0.00	1	1	0.08	0	0	0.00
25-Jun	0	0	0.00	0	1	0.08	0	0	0.00
26-Jun	11	11	0.34	3	4	0.31	0	0	0.00
27-Jun	5	16	0.49	0	4	0.31	0	0	0.00
28-Jun	9	25	0.77	2	6	0.46	0	0	0.00
29-Jun	7	32	0.99	2	8	0.62	0	0	0.00
30-Jun	2	34	1.05	0	8	0.62	0	0	0.00
1-Jul	8	42	1.30	0	8	0.62	0	0	0.00
2-Jul	17	59	1.82	6	14	1.08	0	0	0.00
3-Jul	4	63	1.94	0	14	1.08	0	0	0.00
4-Jul	0	63	1.94	1	15	1.16	0	0	0.00
5-Jul	9	72	2.22	0	15	1.16	0	0	0.00
6-Jul	0	72	2.22	9	24	1.77	0	0	0.00
7-Jul	2	74	2.28	6	30	2.24	0	0	0.00
8-Jul	1	75	2.31	0	30	2.24	0	0	0.00
9-Jul	0	75	2.31	2	32	2.39	0	0	0.00
10-Jul	5	80	2.47	3	35	2.62	0	0	0.00
11-Jul	19	99	3.06	15	50	3.78	0	0	0.00
12-Jul	5	104	3.21	53	103	7.86	0	0	0.00
13-Jul	2	106	3.27	29	132	10.10	0	0	0.00
14-Jul	5	111	3.43	5	137	10.49	0	0	0.00
15-Jul	3	114	3.52	4	141	10.79	0	0	0.00
16-Jul	8	122	3.77	3	144	11.03	0	0	0.00
17-Jul	12	134	4.14	4	148	11.33	0	0	0.00
18-Jul	72	206	6.36	4	152	11.64	0	0	0.00
19-Jul	56	262	8.09	28	180	13.80	0	0	0.00
20-Jul	8	270	8.33	0	180	13.80	0	0	0.00
21-Jul	25	295	9.10	0	180	13.80	0	0	0.00
22-Jul	33	328	10.12	3	183	14.03	0	0	0.00
23-Jul	0	328	10.12	8	191	14.65	0	0	0.00
24-Jul	55	383	11.82	13	204	15.65	0	0	0.00
25-Jul	29	412	12.72	11	215	16.50	0	0	0.00
26-Jul	9	421	12.99	0	215	16.50	0	0	0.00
27-Jul	11	432	13.33	2	217	16.65	0	0	0.00

Appendix 2. Continued

Date	Chum Salmon			Chinook Salmon			Coho Salmon		
	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
28-Jul	49	481	14.85	4	221	16.96	1	1	0.10
29-Jul	113	594	18.33	52	273	20.97	2	3	0.31
30-Jul	34	628	19.38	5	278	21.36	2	5	0.52
31-Jul	82	710	21.91	2	280	21.51	2	7	0.72
1-Aug	94	804	24.81	201	481	37.01	1	8	0.83
2-Aug	176	980	30.25	13	494	38.01	7	15	1.55
3-Aug	256	1,236	38.14	435	929	71.55	5	20	2.06
4-Aug	68	1,304	40.23	17	946	72.86	0	20	2.06
5-Aug	40	1,344	41.47	4	950	73.17	1	21	2.17
6-Aug	169	1,513	46.68	55	1,005	77.41	0	21	2.17
7-Aug	233	1,746	53.87	39	1,044	80.42	2	23	2.37
8-Aug	139	1,885	58.16	59	1,103	84.97	0	23	2.37
9-Aug	123	2,008	61.96	73	1,176	90.59	2	25	2.58
10-Aug	139	2,147	66.24	22	1,198	92.29	0	25	2.58
11-Aug	239	2,386	73.62	19	1,217	93.75	2	27	2.79
12-Aug	229	2,615	80.68	25	1,242	95.68	27	54	5.57
13-Aug	113	2,728	84.17	14	1,256	96.76	5	59	6.09
14-Aug	99	2,827	87.23	2	1,258	96.92	13	72	7.43
15-Aug	40	2,867	88.46	3	1,261	97.15	7	79	8.15
16-Aug	36	2,903	89.57	1	1,262	97.22	7	86	8.88
17-Aug	77	2,980	91.95	21	1,283	98.84	3	89	9.18
18-Aug	28	3,008	92.81	1	1,284	98.92	7	96	9.91
19-Aug	41	3,049	94.07	2	1,286	99.07	5	101	10.42
20-Aug	0	3,049	94.07	0	1,286	99.07	0	101	10.42
21-Aug	24	3,073	94.82	2	1,288	99.23	5	106	10.94
22-Aug	22	3,095	95.49	4	1,292	99.54	26	132	13.62
23-Aug	22	3,117	96.17	2	1,294	99.69	4	136	14.04
24-Aug	38	3,155	97.35	2	1,296	99.85	7	143	14.76
25-Aug	20	3,175	97.96	1	1,297	99.92	29	172	17.75
26-Aug	17	3,192	98.49	1	1,298	100.00	10	182	18.78
27-Aug	13	3,205	98.89	0	1,298	100.00	52	234	24.15
28-Aug	7	3,212	99.10	0	1,298	100.00	52	286	29.51
29-Aug	6	3,218	99.29	0	1,298	100.00	62	348	35.91
30-Aug	3	3,221	99.38	0	1,298	100.00	191	539	55.62
31-Aug	6	3,227	99.57	0	1,298	100.00	140	679	70.07

Appendix 2. Continued

Date	Chum Salmon			Chinook Salmon			Coho Salmon		
	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
1-Sep	6	3,233	99.75	0	1,298	100.00	54	733	75.64
2-Sep	1	3,234	99.78	0	1,298	100.00	49	782	80.70
3-Sep	2	3,236	99.85	0	1,298	100.00	22	804	82.97
4-Sep	0	3,236	99.85	0	1,298	100.00	24	828	85.45
5-Sep	0	3,236	99.85	0	1,298	100.00	21	849	87.62
6-Sep	4	3,240	99.97	0	1,298	100.00	91	940	97.01
7-Sep	1	3,241	100.00	0	1,298	100.00	29	969	100.00
Total	3,241	3,241	100.00	1,298	1,298	100.00	969	969	100.00

Appendix 3. Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of chum, chinook and coho salmon escapement through the Big Creek weir, 2001.

	Chum Salmon			Chinook Salmon			Coho Salmon		
Date	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
24-Jun	0	0	0.00	1	1	0.15	0	0	0.00
25-Jun	0	0	0.00	0	1	0.15	0	0	0.00
26-Jun	0	0	0.00	0	1	0.15	0	0	0.00
27-Jun	0	0	0.00	0	1	0.15	0	0	0.00
28-Jun	1	1	0.01	1	2	0.31	0	0	0.00
29-Jun	6	7	0.06	1	3	0.46	0	0	0.00
30-Jun	1	8	0.07	0	3	0.46	0	0	0.00
1-Jul	0	0	0.07	0	3	0.46	0	0	0.00
2-Jul	4	12	0.10	3	6	0.92	0	0	0.00
3-Jul	6	18	0.15	2	8	1.23	0	0	0.00
4-Jul[a]	1	19	0.16	0	8	1.23	0	0	0.00
5-Jul	15	34	0.28	0	8	1.23	0	0	0.00
6-Jul	13	47	0.39	1	9	1.39	0	0	0.00
7-Jul	49	96	0.80	1	10	1.54	0	0	0.00
8-Jul	130	226	1.89	0	10	1.54	0	0	0.00
9-Jul	161	387	3.23	1	11	1.69	0	0	0.00
10-Jul	108	495	4.13	9	20	3.08	0	0	0.00
11-Jul	31	526	4.39	5	25	3.85	0	0	0.00
12-Jul	24	550	4.59	1	26	4.01	0	0	0.00
13-Jul[b]	78	628	5.24	1	27	4.16	0	0	0.00
14-Jul	33	661	5.52	3	30	4.62	0	0	0.00
15-Jul	220	881	7.35	6	36	5.55	0	0	0.00
16-Jul	336	1,217	10.16	18	54	8.32	0	0	0.00
17-Jul	367	1,584	13.22	3	57	8.78	0	0	0.00
18-Jul	473	2,057	17.16	14	71	10.94	0	0	0.00
19-Jul	1,358	3,415	28.50	19	90	13.87	0	0	0.00
20-Jul	351	3,766	31.43	17	107	16.49	0	0	0.00
21-Jul	177	3,943	32.90	5	112	17.26	0	0	0.00
22-Jul	789	4,732	39.49	64	176	27.12	0	0	0.00
23-Jul[c]	0	4,732	39.49	0	176	27.12	0	0	0.00
24-Jul[c]	127	4,859	40.55	1	177	27.27	0	0	0.00
25-Jul	684	5,543	46.25	3	180	27.73	0	0	0.00
26-Jul	566	6,109	50.98	3	183	28.20	0	0	0.00
27-Jul	256	6,365	53.11	17	200	30.82	0	0	0.00

Appendix 3. Continued

Date	Chum Salmon			Chinook Salmon			Coho Salmon		
	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
28-Jul	229	6,594	55.02	17	217	33.44	0	0	0.00
29-Jul	103	6,697	55.88	13	230	35.44	0	0	0.00
30-Jul	402	7,099	59.24	35	265	40.83	0	0	0.00
31-Jul	234	7,333	61.19	31	296	45.61	0	0	0.00
1-Aug	320	7,653	63.86	25	321	49.46	0	0	0.00
2-Aug	31	7,684	64.12	21	342	52.70	0	0	0.00
3-Aug	78	7,762	64.77	14	356	54.85	0	0	0.00
4-Aug	320	8,082	67.44	16	372	57.31	1	1	0.02
5-Aug	664	8,746	72.98	58	430	66.26	1	2	0.04
6-Aug	430	9,176	76.57	69	499	76.89	1	3	0.07
7-Aug	197	9,373	78.21	13	512	78.89	2	5	0.11
8-Aug	43	9,416	78.57	15	527	81.20	0	5	0.11
9-Aug	207	9,623	80.30	15	542	83.51	0	5	0.11
10-Aug	98	9,721	81.12	36	578	89.06	2	7	0.15
11-Aug	122	9,843	82.13	12	590	90.91	5	12	0.26
12-Aug	84	9,927	82.84	16	606	93.37	0	12	0.26
13-Aug	159	10,086	84.16	3	609	93.84	6	18	0.40
14-Aug	141	10,227	85.34	13	622	95.84	2	20	0.44
15-Aug[d]	62	10,289	85.86	18	640	98.61	9	29	0.64
16-Aug	31	10,320	86.11	1	641	98.77	0	29	0.64
17-Aug	50	10,370	86.53	0	641	98.77	7	36	0.80
18-Aug	45	10,415	86.91	0	641	98.77	3	39	0.86
19-Aug	34	10,449	87.19	1	642	98.92	2	41	0.91
20-Aug	181	10,630	88.70	0	642	98.92	5	46	1.02
21-Aug	197	10,827	90.35	0	642	98.92	3	49	1.08
22-Aug	250	11,077	92.43	3	645	99.38	11	60	1.33
23-Aug	210	11,287	94.18	0	645	99.38	2	62	1.37
24-Aug	153	11,440	95.46	0	645	99.38	1	63	1.39
25-Aug	108	11,548	96.36	0	645	99.38	28	91	2.01
26-Aug	29	11,577	96.60	0	645	99.38	14	105	2.32
27-Aug	116	11,693	97.57	0	645	99.38	193	298	6.59
28-Aug	86	11,779	98.29	0	645	99.38	56	354	7.83
29-Aug	30	11,809	98.54	0	645	99.38	16	370	8.18
30-Aug	24	11,833	98.74	0	645	99.38	4	374	8.27
31-Aug	12	11,845	98.84	0	645	99.38	1	375	8.29

Appendix 3. Continued

	Chum Salmon			Chinook Salmon			Coho Salmon		
Date	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
1-Sep	32	11,877	99.12	0	645	99.38	87	462	10.21
2-Sep	16	11,893	99.24	2	647	99.69	131	593	13.11
3-Sep	14	11,907	99.36	0	647	99.69	8	601	13.29
4-Sep	14	11,921	99.47	0	647	99.69	35	636	14.06
5-Sep	17	11,938	99.62	0	647	99.69	62	698	15.43
6-Sep[e]	2	11,940	99.63	0	647	99.69	98	796	17.60
7-Sep[e]	1	11,941	99.64	0	647	99.69	82	878	19.41
8-Sep[e]	9	11,950	99.72	0	647	99.69	165	1,043	23.06
9-Sep	2	11,952	99.73	1	648	99.85	83	1,126	24.89
10-Sep	9	11,961	99.81	0	648	99.85	14	1,140	25.20
11-Sep	3	11,964	99.83	1	649	100.00	76	1,216	26.88
12-Sep	2	11,966	99.85	0	649	100.00	46	1,262	27.90
13-Sep	2	11,968	99.87	0	649	100.00	35	1,297	28.68
14-Sep	3	11,971	99.89	0	649	100.00	133	1,430	31.62
15-Sep	3	11,974	99.92	0	649	100.00	169	1,599	35.35
16-Sep	2	11,976	99.93	0	649	100.00	161	1,760	38.91
17-Sep	1	11,977	99.94	0	649	100.00	310	2,070	45.77
18-Sep	4	11,981	99.97	0	649	100.00	270	2,340	51.74
19-Sep	1	11,982	99.98	0	649	100.00	170	2,510	55.49
20-Sep	0	11,982	99.98	0	649	100.00	165	2,675	59.14
21-Sep	0	11,982	99.98	0	649	100.00	74	2,749	60.79
22-Sep	0	11,982	99.98	0	649	100.00	144	2,893	63.96
23-Sep	0	11,982	99.98	0	649	100.00	114	3,007	66.48
24-Sep	1	11,983	99.99	0	649	100.00	603	3,610	79.81
25-Sep	0	11,983	99.99	0	649	100.00	24	3,634	80.34
26-Sep	0	11,983	99.99	0	649	100.00	9	3,643	80.54
27-Sep	0	11,983	99.99	0	649	100.00	115	3,758	83.09
28-Sep	0	11,983	99.99	0	649	100.00	285	4,043	89.39
29-Sep	0	11,983	99.99	0	649	100.00	88	4,131	91.33
30-Sep	0	11,983	99.99	0	649	100.00	0	4,131	91.33
1-Oct	0	11,983	99.99	0	649	100.00	16	4,147	91.69
2-Oct	1	11,984	100.00	0	649	100.00	216	4,363	96.46
3-Oct	0	11,984	100.00	0	649	100.00	68	4,431	97.97
4-Oct	0	11,984	100.00	0	649	100.00	31	4,462	98.65
5-Oct	0	11,984	100.00	0	649	100.00	36	4,498	99.45

Appendix 3. Continued

	Chum Salmon			Chinook Salmon			Coho Salmon		
Date	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
6-Oct	0	11,984	100.00	0	649	100.00	2	4,500	99.49
7-Oct	0	11,984	100.00	0	649	100.00	10	4,510	99.71
8-Oct	0	11,984	100.00	0	649	100.00	12	4,522	99.98
9-Oct	0	11,984	100.00	0	649	100.00	1	4,523	100.00
Total	11,984	11,984	100.00	649	649	100.00	4,523	4,523	100.00

[a] Beaver compromised weir.
[b] Weir down between 12:00 - 5:00 am and repaired by 2:00 pm.
[c] Weir down early am due to high water and debris. Fish tight by 3:00pm 7/24
[d] Lower weir pulled at 3:30 pm and new weir fish tight by 5:40 pm.
[e] High water, some coho salmon were seen swimming over the weir.

Appendix 4. Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of chum, chinook, and coho salmon escapement through the Big Creek weir, 2002.

	Chum Salmon			Chinook Salmon			Coho Salmon		
Date	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
29Jun[a]	30	30	0.10	1	1	0.02	0	0	0.00
30-Jun[a]	33	63	0.22	3	4	0.08	0	0	0.00
1-Jul[b]	137	200	0.69	9	13	0.27	0	0	0.00
2-Jul[a]	195	395	1.37	0	13	0.27	0	0	0.00
3-Jul	1,051	1,446	5.02	15	28	0.58	0	0	0.00
4-Jul	732	2,178	7.56	13	41	0.86	0	0	0.00
5-Jul	632	2,810	9.75	10	51	1.06	0	0	0.00
6-Jul	1,106	3,916	13.59	44	95	1.98	0	0	0.00
7-Jul[a]	891	4,807	16.68	18	113	2.36	0	0	0.00
8-Jul	1,977	6,784	23.55	150	263	5.49	0	0	0.00
9-Jul	1,212	7,996	27.75	216	479	10.00	0	0	0.00
10-Jul	1,211	9207	31.96	598	1,077	22.48	0	0	0.00
11-Jul	799	10,006	34.73	377	1,454	30.35	0	0	0.00
12-Jul	1,101	11,107	38.55	171	1,625	33.92	0	0	0.00
13-Jul	452	11,559	40.12	35	1,660	34.65	0	0	0.00
14-Jul	245	11,804	40.97	27	1,687	35.21	0	0	0.00
15-Jul	880	12,684	44.02	382	2,069	43.19	0	0	0.00
16-Jul	1,035	13,719	47.62	50	2,119	44.23	0	0	0.00
17-Jul	2,552	16,271	56.47	1,292	3,411	71.20	0	0	0.00
18-Jul	775	17,046	59.16	93	3,504	73.14	0	0	0.00
19-Jul	573	17,619	61.15	441	3,945	82.34	0	0	0.00
20-Jul	333	17,952	62.31	24	3,969	82.84	0	0	0.00
21-Jul	703	18,655	64.75	46	4,015	83.80	0	0	0.00
22-Jul	485	19,140	66.43	10	4,025	84.01	0	0	0.00
23-Jul	434	19,574	67.94	27	4,052	84.58	0	0	0.00
24-Jul	696	20,270	70.35	6	4,058	84.70	0	0	0.00
25-Jul[a]	290	20,560	71.36	32	4,090	85.37	0	0	0.00
26-Jul[a]	198	20,758	72.05	2	4,092	85.41	0	0	0.00
27-Jul	533	21,291	73.90	38	4,130	86.20	0	0	0.00
28-Jul	886	22,177	76.97	37	4,167	86.98	0	0	0.00
29-Jul	908	23,085	80.12	126	4,293	89.61	0	0	0.00
30-Jul	1,028	24,113	83.69	49	4,342	90.63	0	0	0.00
31-Jul	772	24,885	86.37	68	4,410	92.05	2	2	0.25
1-Aug	371	25,256	87.66	30	4,440	92.67	0	2	0.25

Appendix 4. Continued

Date	Chum Salmon			Chinook Salmon			Coho Salmon		
	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
2-Aug	437	25,693	89.17	40	4,480	93.51	3	5	0.62
3-Aug	516	26,209	90.97	11	4,491	93.74	3	8	0.99
4-Aug	78	26,287	91.24	6	4,497	93.86	0	8	0.99
5-Aug	194	26,481	91.91	7	4,504	94.01	1	9	1.12
6-Aug	183	26,664	92.54	105	4,609	96.20	4	13	1.61
7-Aug	161	26,825	93.10	5	4,614	96.31	1	14	1.74
8-Aug	154	26,979	93.64	3	4,617	96.37	1	15	1.86
9-Aug	269	27,248	94.57	51	4,668	97.43	10	25	3.10
10-Aug	168	27,416	95.15	9	4,677	97.62	0	25	3.10
11-Aug	118	27,534	95.56	6	4,683	97.75	2	27	3.35
12-Aug	136	27,670	96.04	16	4,699	98.08	2	29	3.60
13-Aug	149	27,819	96.55	14	4,713	98.37	13	42	5.21
14-Aug	97	27,916	96.89	13	4,726	98.64	17	59	7.32
15-Aug	126	28,042	97.33	4	4,730	98.73	2	61	7.57
16-Aug	145	28,187	97.83	9	4,739	98.91	4	65	8.06
17-Aug	69	28,256	98.07	13	4,752	98.19	11	76	9.43
18-Aug	121	28,377	98.49	10	4,762	99.39	19	95	11.79
19-Aug	66	28,443	98.72	2	4,764	99.44	2	97	12.03
20-Aug	94	28,537	99.05	1	4,765	9946	16	113	14.02
21-Aug	33	28,570	99.16	1	4,766	99.48	0	113	14.02
22-Aug	24	28,594	99.24	0	4,766	99.48	0	113	14.02
23-Aug	26	28,620	99.33	0	4,766	99.48	4	117	14.52
24-Aug	37	28,657	99.46	0	4,766	99.48	4	121	15.01
25-Aug	14	28,671	99.51	0	4,766	99.48	1	122	15.04
26-Aug	4	28,675	99.52	0	4,766	99.48	6	128	15.88
27-Aug	5	28,680	99.54	1	4,767	99.50	1	129	16.00
28-Aug	11	28,691	99.58	0	4,767	99.50	0	129	16.00
29-Aug	6	28,697	99.60	2	4,769	99.54	0	129	16.00
30-Aug	36	28,733	99.73	5	4,774	99.64	26	155	19.23
31-Aug	12	28,745	99.77	1	4,775	99.67	15	170	21.09
1-Sep	15	28,760	99.82	2	4,777	99.71	50	220	27.30
2-Sep	17	28,777	99.88	2	4,779	99.75	64	284	35.24
3-Sep	11	28,788	99.92	1	4,780	99.77	40	324	40.20
4-Sep	10	28,798	99.95	6	4,786	99.90	78	402	49.88
5-Sep	11	28,809	99.98	5	4,791	100.00	234	636	78.91

Appendix 4. Continued

	Chum Salmon			Chinook Salmon			Coho Salmon		
Date	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%	Daily	Cum.	Cum.%
6-Sep	2	28,811	99.99	0	4,791	100.00	76	712	88.34
7-Sep	1	28,812	100.00	0	4,791	100.00	94	806	100.00
Total	28,812	28,812	100.00	4,791	4,791	100.00	806	806	100.00

[a] Broken, rivet, picket, or cable. Several fish escaped.

[b] Video gate shifted, no longer fish tight.